Climate Change, Watershed Management, and Resiliency to Flooding: A Case Study of Papeno'o Valley, Tahiti Nui (French Polynesia)

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ABSTRA CT

Mā'ohi communities in Tahiti Nui are adaptive to changing times. Historically, this has been shown through the ways that communities have adapted to changing weather, changing land issues, continuous migration, and Western acculturation. This type of adaptability and knowledge of adaptability will be of use in addressing upcoming climate change issues that Tahiti Nui will face. Papeno'o Valley, Tahiti is prone to yearly flooding due to heavy rains during the rainy season, especially during the months December, January and February. Scientific evidence suggests that global climate is changing, which anticipates that these yearly rainfalls and flooding will increase. In response, ways of adapting to these changing times is necessary and important. A combination of adaptation methods such as community awareness of risks through oral histories, restoring natural floodzones, and managed retreat will help to ensure stability of the people of this valley and the livability of this valley over the long-term, which constitutes as resiliency. This thesis examines the ways in which Mā'ohi communities respond to flooding in Papeno'o, how government agencies respond to flooding in Papeno'o and concludes with how to maximize both efforts into a more collaborative approach for resiliency in the valley.

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IPCC	Intergovernmental Panel on Climate Change
GHG	Greenhouse Gases
PACC	Pacific Adaptation to Climate Change
PAD	Zoning and Construction Plan **(**Plan D'Amenagement**)**
PCS	Strategic Climate Plan **(**Plan Climat Strategique**)**
PPR	Risk Prevention Plan **(**Plan Prevention de Risques**)**
SAU	Service de L'Urbanisme
SPC	Secretariat of the Pacific Community
SPCZ	South Pacific Convergence Zone
SPREP	Secretariat of the Pacific Regional Environment Program

Introduction, Research Approach, and Framework

Mā'ohi communities in Tahiti Nui are adaptive to changing times.[1][2][3] Historically, this has been shown through community ability to adapt to changing weather, changing land issues, continuous migration, and Western acculturation, just to name a few substantial changes (Kahn 2000; Rolett 2008). This type of history is important in understanding how Mā'ohi communities approach issues for the future.

Papeno'o Valley (Fig. 1), which is located on Tahiti island, has a rich history of movement, migration, dealings with wars and Western contact (Manu-Tahi 1997; Hiro'a 2008). Being able to adapt and maintain stability to changes from inside and outside influences is an important aspect of maintaining a community over the long-term, which constitutes as resiliency. In the case of Papeno'o valley, adapting to change and resiliency to change will be of great importance for current and future issues related to flooding and rainfall.

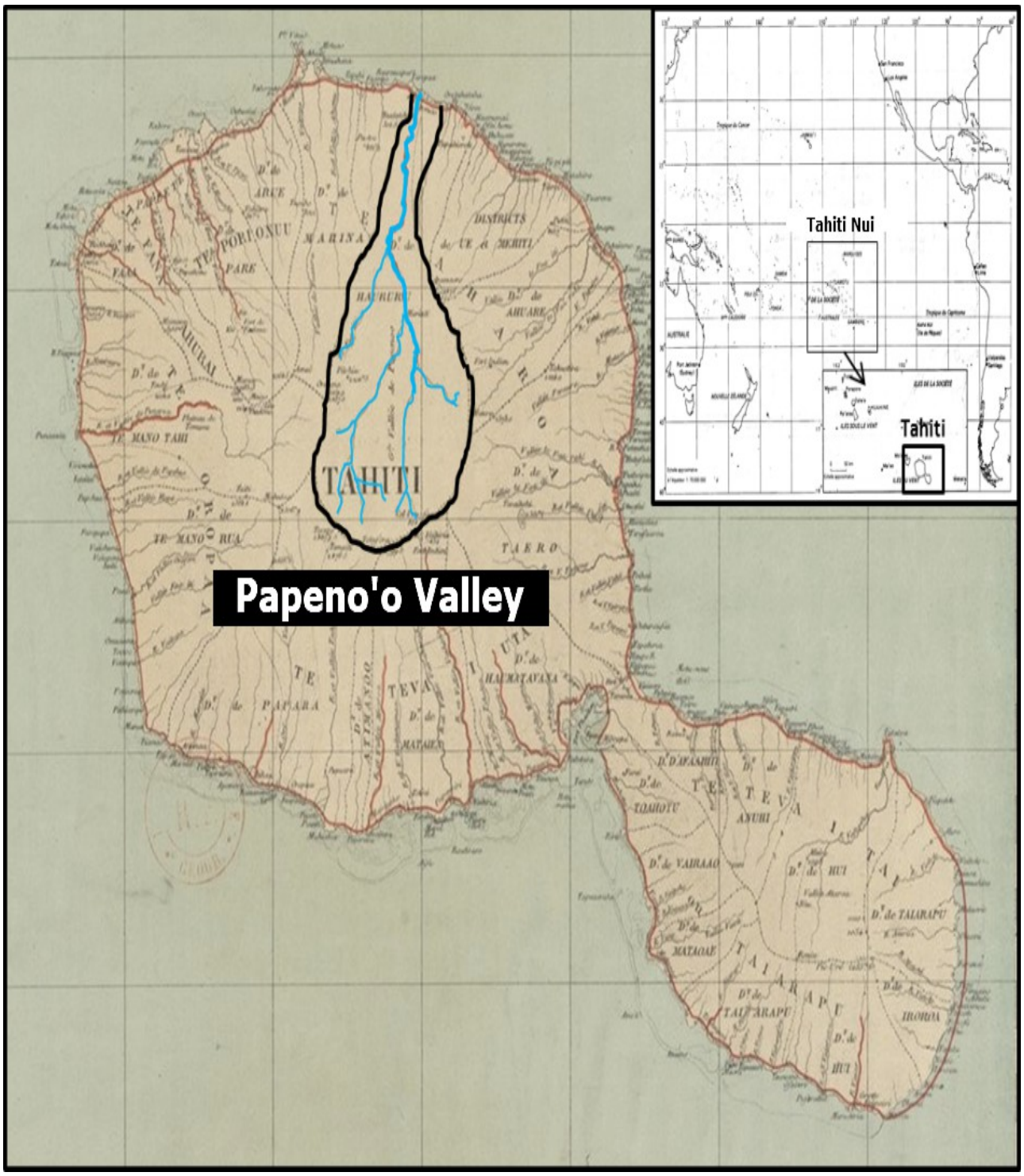
For centuries, seasonal rains have affected the area of Papeno'o and the Eastern side of Tahiti island. Because of its eastern location, Papeno'o is exposed to heavy rainfall due to trade winds that flow from East to West. Pheulpin et al. (2014, 10) state that "mean annual precipitation on the western coast [of Tahiti island] is about 1,500 mm and about 3,500 on the eastern coast. Rainfall can reach 8,500 mm on the reliefs of the eastern coast." Heavy rainfalls in Papeno'o Valley happen yearly during

1 Mā'ohi refers to the solidarity of identity of the different communities in Tahiti Nui. (Ra'apoto 1988, 3-7)

2 The colonial region known as "French Polynesia" will be referenced in speaking of the government and state actors of the territory, who are present on the islands. In an effort to gain solidarity of the five culturally different archipelagos which are colonized by France, local leaders have introduced the names "Tahiti Nui" and "Te Ao Mā'ohi." This thesis will refer to the solidarity of islands as "Tahiti Nui" when not speaking of the French government and state actors (Gonschor 2008, 1).

3 Mā'ohi vocabulary will be defined at first-use and non-italicized. (Casey 2016, xiii)

Fig. 1: Map of Tahiti Nui, Tahiti island and Papeno'o Valley



(Helm 2017)

the Matari'i-i-Ni'a season, and especially during the months December, January, and February (Avagliano 2009, 15-16).

In December of 2015, these heavy rainfalls had serious effects on the land and people in the valley, such as destroyed homes and roads, which have led to issues of displacement and problems with transportation ("A Faaripo" 2015). This thesis will cover the issues related to rainfall and flooding that occurred in December 2015. Results of the heavy rainfalls are well-documented by the two main news sources in Tahiti Nui, TNTV and Polynésie 1ère, and in the memory of Papeno'o community members. "The rooms are wet, full of mud. We just renovated the house. We must do it again. We have to start from scratch," states one Papeno'o resident ("Inondations : à Faaripo 2015). Throughout occupied areas of Papeno'o, there were issues of extreme fooding in housing areas and road structures.

Climate Change, Resiliency and Why it's Important

As Papeno'o is already susceptible to seasonal rains and potential floods, preparing for an increase in rainfall over the next few decades is imperative.[4] A pressing need for this is driven by issues of climate change.

Pacific Islands have historically experienced extreme weather patterns, such as cyclones, droughts and floods (Rollett 2008, 8). Scientific evidence shows that climate has been changing in the past few decades, and there will be potentially immeasurable effects on entire lands and populations of people (IPCC Factsheet 2013). Pacific Islands which often sit right at seal-level, and have developed coastal communities are extremely vulnerable to natural disasters. While Pacific Islands omit extremely trace amounts of greenhouse gases compared to other large countries, unfortunately, despite

4 This thesis acknowledges that Papeno'o Valley experiences a multitude of hazards and risks other than flooding, such as landfalls, erosion, and sea level rise, but this paper does not explore the options of resiliency towards these other hazards. I acknowledge their importance, but did not have the capacity to accurately write and cover those issues, which is why this paper focuses solely on flooding.

their lack of usage, are among the most impacted by the environmental results of greenhouse gas emissions (Betzhold 2015).

Studies link the changing climate to a result of human impact and CO2 emmissions into the atmosphere due to industrialization of Western countries. Some studies cite this as the "anthropocene," defined as "the human imprint on the global environment," in which for the first time in history, human impact has resulted in global climate change (Steffen, Grinevald, Crutzen 2011). Although, as stated earlier, Pacific Islanders produce very little carbon emmissions in comparison to Western countries, the origin of industrialization. Therefore, the broad term of "humans" misrepresents world power dynamics, in which there are some Western countries where humans are causing a changing climate and there are peoples worldwide that aren't creating these global temperature changes, and yet, are are still affected by this changing climate in very serious ways (Moore et al. 2016).

A changing climate for the Pacific could mean a variety of issues, most notably sea-level rise, increasing global temperatures, erratic precipitation patterns, more frequent and severe storms along with a variety of environmental extremes (CMB 2017). There are islands and atolls in the Pacific, which are currently at a high-risk of sea-level rise in our current day, such as the Marshall Islands and Kiribati (Campbell 2014). The reality of a changing climate puts Pacific Islanders in the position to be ready for this change, as it is currently happening, and could have devastating effects in the near and changing future.

When addressing natural disasters in the Pacific, and issues of a changing climate in the Pacific, resiliency is an approach which consists of a set of measures that allow a community to maintain its stability in changed conditions. In the face of natural disasters and hazards, many scholars encourage resiliency as a means of maintaining communities. Jon Barnett (2001, 984) states, "It is important to recognize that the pursuit of resilience is integral to the development of adaptive capacity. This is because, an integral feature of resilient systems is an ability to learn from, and reorganize to meet,

changed conditions. In short, a resilient system carries with it the essential qualities for adaptation."

In resiliency, there are a variety of approaches to be used, among them are adaptation and mitigation, two significant overarching mainstream approaches. The IPCC (Intergovernmental Panel on Climate Change) defines mitigation as "human intervention to reduce the sources or enhance the sinks of greenhouse gases" (IPCC 2012, 561). Because Pacific Islanders produce trace amounts of greenhouse gases, this thesis does not focus on mitigation, as that would be the responsibility of countries who are the producers of these gases.

The IPCC defines adaptation as "the process of adjustment to actual or expected climate and its effects, in order to moderate harm or exploit beneficial opportunities. In natural systems, the process of adjustment to actual climate and its effects; human intervention may facilitate adjustment to expected climate" (IPCC 2012, 556). This thesis will focus on adaptation methods in Papeno'o Valley, which are discussed at length in Chapter 3.

For the Pacific, there is little evidence to show that Pacific Islanders have driven themselves into extinction or into an environment that is unsustainable. The most famous outlier against this idea is Jared Diamond who argues that Rapa Nui people have led themselves into "collapse," but this author's argument does not go unchallenged. Many scholars strongly contest Diamond's theory of "collapse," questioning his positionality, his solely Western sources, and methods of engagement with knowledge, in which anthropologist Forrest Wade Young classifies this as an "ethnocentric occidental fashion" of doing research (Young 2012, 6).

In contrast, many indigenous and Pacific Island scholars and scientists worldwide in the current day celebrate the fact that indigenous peoples' have historically had strong connections to their environment, which produce harmony and balance between humans and environment, not a domination of nature or towards detrimental environmental effects (McMillen et al. 2014; Nunn 2017; Minerbi 1999; Mayer 2014; Bambridge 2016). This is not to romanticize indigenous peoples' relationship with

environment, it is to acknowledge that there are many ways to live in the world and with the world.

For community members of Papeno'o and Mā'ohi communities in general, through this thesis and with support of scholars mentioned previously, I argue that resiliency is a natural and integral part of Pacific Island cultures. But the aspect of climate change, as Nunn (2009) argues, creates a contmporary dynamic, in which governments and their resources could aid in resiliency measure and methods to Papeno'o community members.

For the issues of flooding in Papeno'o, this thesis first focuses on response methods from civic communities in Papeno'o, and also the response methods used by the government. Methods from both sectors will be examined because both parties hold valuable capacity in response and adaptation.

While both parties hold capacity for response, adaptation and resiliency, there may be areas where there can be stronger overlap in methods or collaboration, which this thesis explores. After assessing where governments and communities are at currently, this thesis then explores ways at better collaboration between government approaches and community approaches to resiliency.

The idea of climate change resiliency is supported by Pacific environmental regional organization SPREP who states that every decision made regarding land use and planning should incorporate how climate change will affect the area, referring to this as "mainstreaming climate resiliency" (Jasperse 2014, 3). The purpose of this approach is to acknowledge that climate change is happening and has numerous effects on land and peoples. This is to prepare for the future and take preventative measures in potential damage that could occur areas.

The pressing need to address natural hazards and preparedness is a primary motivation of this thesis. This thesis highlights ways that Mā'ohi communities are already perpetuating that resiliency and explore ways that resiliency can be improved by communities and government agencies in working together.

Methodologies and Positionality

This thesis takes into account two different disciplines in collecting research and the formulation of the following chapters: Urban Planning and Pacific Island Studies. Pacific Island Studies is an interdisciplinary space of scholarship. Pacific Island scholar Teresia Teaiwa states that the wealth of research done concerning the Pacific previously published through different disciplines should be used in producing Pacific Island Studies scholarship for today, which I have used to inform historical accounts of Papeno'o valley (Teaiwa 2010, 113). Being used are texts from scholars such as historians Charles Newbury and Charles ManuTahi; archaeologists Orliac and Eddowes; and anthropological authors, Bruno Saura and Bernard Rigo.

In creating contemporary Pacific Island Studies scholarship, I am influenced by Pacific scholars such as Konai Helu Thaman and Linda Tuhiwai-Smith. Thaman (2003, 2) writes, "Decolonizing Pacific studies is about reclaiming indigenous Oceanic perspectives, knowledge, and wisdom that have been devalued or suppressed because they were or are not considered important or worthwhile." While she is speaking of the discipline Pacific Studies, this comment is applicable to my research, as I do not want to perpetuate the ways that "Oceanic perspectives, knowledge, and wisdom [. . .] have been devalued or suppressed." I tried to use Mā'ohi knowledge and wisdom when appropriate. In determining whether or not Mā'ohi knowledge and wisdom could be used, I tried to gather a diverse range of input from cultural practitioners, scholars, and Papeno'o community members on their opinions about how and when to incorporate appropriate knowledge. These knowledges were a combination of oral histories, songs and chants, place names, and Matari'i-i-ni'a, the knowledge of seasonal changes through environment and astronomy as discussed most significantly in Chapter 1 of this thesis (Nakoa & Wright 2015; Minerbi 2003).

Regarding the future of Pacific Island Studies scholarship, Teaiwa states important ways of conducting and applying research, which is more than pertinent to my work, and an inspiration for it.

On page 113 of "For or *Before* an Asia Pacific Agenda?" Teaiwa (2010) states, "As more Pacific researchers and academics emerge, a need to subvert and refashion academic space and practice has become increasingly strong in its expression. Manifestos for appropriate research design, methodology, and publication have been launched that insist on community consultation and participation at all levels and that push for relevance, applicability and ultimately the empowerment of indigenous communities (see Smith 1999; Anae et al. 2001; Sanga and Pasikale 2002; Meyer 2001)."

With this quote, there are three points which I have coalesced with Urban Planning methodologies to create this thesis: subversion, encouragement of community consultation and participation and applicability.

Subversion: Urban Planning is the planning of space and land, which is relevant when looking at Papeno'o Valley. This is a discipline that comes from the West, and these methodologies and practice have historically been used to impose Western values and spatial understandings on Mā'ohi land. In Urban Planning there is the possibility of not acknowledging indigenous epistemologies and creating policies and plans that do not reflect how people come to understand their worldview.[5] As scholar Linda Tuhiwai-Smith (1999, 51) states in *Decolonizing Methodologies*:

> For the indigenous world, Western conceptions of space, of arrangements and display, of relationship between people and the landscape, of culture as an object of study, have meant that not only has the indigenous world been represented in particular ways to the West, but the indigenous world view, the land and the people, have been radically transformed in the spatial image of the West.

The most recent and significant way Tahiti Nui has been affected by a Western style of Urban Planning

5 The word "indigenous" is used by Pacific Island scholars to describe Pacific Islanders, which include Mā'ohi peoples. Because there is debate over whether Mā'ohi people identify as indigenous, the word Mā'ohi, rather than the word indigenous, will be used when speaking specifically of Mā'ohi peoples. (Gagné 2015)

is through the third acculturation of Tahiti Nui: the era of nuclear testing, the development of the *Centre d'Experimentation du Pacifique,* and the subsequent infrastructure to support the nuclear testing agenda starting in 1962. The development of Pape'ete city is in mirror to a French city - when one arrives today in Pape'ete there are French cars everywhere, small and skinny French-style roads, schools, hospitals, road signs in French, and French-style homes and buildings. It is unmistakable that this is a French colony (Mallol 2010, 310-312). Pape'ete was styled and designed by urban planners who had French ideas of how to build on land.

While Urban Planning methodologies and practice have been historically used to impose Western values and spatial understandings on Mā'ohi land, there are ways to *subvert* this discipline to benefit the local people and land, as a way to disrupt the continuation of Western values in Urban Planning. I could use solely Western forms and definitions of resiliency, and I indeed use theories and frameworks that come from the West in defining resiliency. But on Mā'ohi land, I'm also choosing to examine how Mā'ohi knowledges have kept Mā'ohi people resilient in Papeno'o Valley for centuries and prioritize these knowledges towards future planning of Papeno'o. As discussed earlier, many scholars have acknowledged that Pacific peoples' have relationships and systems with land that has endured for centuries.

One of the main strengths of Pacific Island Studies is the critical discussions and questions about history and politics of the Pacific that are used to form this discipline. Pacific Island Studies can push conversations that are happening in our department into other disciplines and domains, such as Urban Planning. Pacific scholar Lea Lani Kauvaka recognizes the critical conversations of Pacific Island Studies that provide understandings of power dynamics happening there,

> Thus my feeling is that the multiply situated and now increasingly instituted Pacific studies demands a return of the discourse to the landedness signified by berths, anchors, and anchorages in order to ground and multiply the many "edges" of Pacific studies to each of their

> place-based institutional contexts and ensure continuity of the critical questions of power, history, and politics that form a core part of the powers that cultural studies develops to interrupt and achieve its ideals of transformation (2015, 137).

As a discipline, with a critical background, in a Western institution (acadamia), Pacific Island Studies holds power in its position. This discipline is validated as creating knowledge and being respected by other Westerners, so it should be the responsibility of this discipline to speak to these other Western institutions to push them further in their thinking - have those critical conversations within every discipline possible, so those disciplines and governments even, can have better critical, non-oppressive, decolonized understandings of the Pacific.

This same author has investigated the Audre Lorde quote, "the masters tools will not dismantle the master's house" (2015, 146) stating that for her, the only way to dismantle the master's house is *with* the master's tools. In this statement, she is examining how the Western systems we live in today, which represents the master's house, can be decolonized using the master's tools, such as acadamia. This is relevant to my own research, as I am working within the Western system (the master's house) and using a Western framework, Urban Planning (the master's tools) to conduct and produce the research. My attempt at subversion is at positioning myself so I can make the inside of the house reflect Mā'ohi knowledges. In the end, I am a proponent of using any and all tools necessary to dismantle and bring down the master's house - whether it be with the master's tools, Mā'ohi tools, invented tools, etc.

Community Engagement: While Urban Planning has had it's own history of imposition, there has been a development in the department to hold values that Teaiwa has mentioned, such as *community engagement*. In Urban Planning there is a push to first be reflexive - the need to examine one's position, history, ways of knowing and ways of understanding the world while conducting research and producing research (Fischler 2012). As a result of this evolution, the most significant

benefit of Urban Planning is the acknowledgement that acadamia does not and cannot hold all the knowledges, conversations and realities of communities, but there is valuable knowledge held in these communities. This priority of community engagement in Urban Planning has inspired me to involve myself with a Papeno'o-based cultural group named Haururu (Peaceful Waves).

Serving the area since February 14, 1994, Haururu focuses on "protection, management and development of Papeno'o" ("Haururu Ati" 2015). They also have a deep understanding and commitment of cultural value and connection to the valley of Papeno'o, which overlaps with environmental protection and connection to the people, which is relevant to my research of culture and environment ("Haururu" 2016).

This group was formed in 1994 when community members of Papeno'o protested a series of dams that were proposed to be constructed in the valley along Papeno'o River. They lost the fight in the dam, but have remained a group since then and they are currently most famously known to be caretakers of Fare Hape, a marae (sacred temple) which rests 18km into the Valley (Helm 2017). They do educational work on oral histories of Tahiti Nui, marae ceremonies, astronomy as it relates to canoe navigation, among many, many other activities in and around Tahiti Nui. They have alliances with many community organizations around Tahiti, working closely with Fa'afaite (the Tahitian sailing canoe), Association 193 - an organization who works for nuclear justice and reparations for those affected by nuclear testing, and also with the Independence Party of Tahiti Nui - Tavini Huira'atira.

In order to work with Haururu, I made sure to follow certain Mā'ohi protocols which were important for me to do as a way of showing respect for their involvement with me. This was also important because Haururu, as a cultural group, values Mā'ohi protocols, so it's important to show respect for what they deem important. Through conversation with insiders of Mā'ohi culture, I was able to gather information about culturally-appropriate protocols before conducting research in Tahiti Nui. I cannot share all the protocols that were between members of Haururu and myself because that is

knowledge that private and not for an academic space. But one important protocol I can share is called fa'atauaroha, which is the offering of love. Because I did not grow up in Papeno'o, I am therefore an outsider to Papeno'o, a ta'ata 'ē. The first part of the protocol, as an outsider, is to ask if I could go to the valley and do research. In return they offered fa'ari'ira'a (receiving someone as a guest). In response, I went to Papeno'o to do research, and made sure to bring taiha'a horo'a (gifts, as a form of saying thank you) because gift-giving is important in Tahitian culture, and another way to give aroha. I came with food gifts from Hawai‘i, such as chocolate-covered macadamia nuts. They gave to me by introducing me to people, letting me attend their events and ceremonies, giving me rides to places, and buying me lunch. I would in return do any work that they asked me to do, such as translation of Mā'ohi songs into English for their database, and doing research on Hawai‘i when they wanted to know more about Kanaka Maoli culture. And we continued this reciprocal relationship where I gave and they also gave, enacting the fa'atauaroha. At the end of my studies and thesis, I will make sure to give back again with a finished product of this work, which will be further discussed in the Conclusion of this thesis.

To enact this type of protocol was very important for several reasons and related to my insider/outsider positionality. I have genealogical roots to Tahiti Nui as my mother can trace genealogy to these islands since time immemorial, which gives me an insider position. But, I myself, was born and raised in Hawai‘i, which means I am an outsider to these islands in many ways. Also, my father comes from four generations of settlers on Turtle Island (known as the settler colony "The United States of America"), which adds another outsider dimension to my identity. Many people in Tahiti Nui, including my blood relatives, would not acknowledge my relationship to the islands there, and state that I was simply and basically a "Hawaiian," seen only as an outsider. In their definition, in the least, a Mā'ohi or Tahitian person is someone who has the lived experience of growing up on the land of their ancestors, not somewhere else.

But there are others who do validate my identity and genealogical connection to Tahiti Nui as a way of being Mā'ohi or Tahitian, including other blood relatives. The way to understand identity is complicated and changes with context.

I consider myself an insider/outsider, a Mā'ohi person with a diaspora experience of growing up in Hawai'i with a Tahitian diaspora community. This understanding for myself has been a lifelong personal journey which I don't want to share in an academic space, but nonetheless it is my position and that is how I relate to Tahiti Nui and Mā'ohi people there. As if I am one of them and as if I am also an outsider.

Because I consider myself an insider, I chose to work with Haururu as this aligns with my own value of Mā'ohi epistemologies. Growing up in Hawai'i with the Tahitian diaspora community, we would come together for parties and hold bringues (a party where everyone sings Mā'ohi songs and plays instruments). The academy believes that they are the producers of knowledge, and I do not deny that they produce knowledge. But in Mā'ohi culture, I understand the production of knowledge as a communal way of sharing and learning together, in the way that bringue has taught me. We do not always look to someone for knowledge (an expert), but we collaborate and learn it together intergenerationally, in very relaxed and fun settings surrounded by music and laughter. I've learned to sing and play musical instruments through these bringues, in which I was encouraged to share my voice along with others (of differing skill-levels) in that same setting. So it's more than appropriate for me to look to my Mā'ohi community for knowledge and participation in my thesis and research work.

The group Haururu was accepting to me, and took into account my relation to land due to genealogy, and validated that. My interpretation of this is that they are cultural practitioners that recognize genealogy and history as aspects of cultural identity.

Because of this insider/outsider position, I have more to prove because people might already be suspicious about who I am because I did not grow up in Tahiti Nui. To add another aspect of outsider

position, I am someone who is a resercher associated with acadamia. As stated earlier, Haururu is not a group of academics, they are community members with critical views on French colonialism, and Western/outsider positionality and production of knowledge. This was apparent when I first met with Haururu members, and I had to answer a series of questions about my background knowledge of Tahiti Nui and Hawai‘i, about what motivated my research, and about how I was going to conduct research. This only emphasized that I need to be solid in what I'm doing and why, to learn as much as possible about cultural history and knowledge, and in the least, to follow protocol of giving.

This explanation of protocol, positionality and reflexivity is to acknowledge and validate that people may question who you are, why you are there, and where you are going with the information. It's important to constantly be reflexive in the research process because positionality changes with context, as I switch from outsider to insider in different situations. Any researcher attempting to do research in Tahiti Nui should examine and respect these cultural differences, historical power dynamics, and protocols, even myself.

Applicability: Haururu as a group works towards cultural empowerment and perpetuation, and therefore is very critical of Western (French) imposition on the lives of Mā'ohi people. When working with this group, I had to be reflexive in my intentions and ensure that my research would be relevant to their lives and applicable. Many members of Haururu are very critical of acadamia, because it is a colonial institution which has historically misrepresented our cultures, many researchers have not done work in the community, and Haururu doesn't feel supported by acadamia in their own research. Members of Haururu would warn me not to read books that were written by outsiders or in the past because these books would be inaccurate histories or misrepresentations of the culture. I agree with them, and it is not a secret that there has been a history of blatant racism and Pacific Orientalism in research and representation in Tahiti Nui (Wesley-Smith 1995). This is shown by the constant, current-day tourism industry narratives that portray our lives and lands as idyllic, as a happy paradise for

vacation, as simple people with simple lives (Kahn 2000). Or the ways that novelist Alan Moorehead has represented us in his book, *The Fatal Impact*, as if to say we are inferior and destined to erode away due to the eventual and predicted domination of the West over our lives.

I also agree with Haururu in the critiques of acadamia, as I often feel that acadamia creates knowledge through priviledge and monetary resources, but these knowledges and resources do not necessarily impact the lived, material realities of community members in Oceania. Pacific scholar Lea Lani Kauvaka supports my own sentiments in her essay, "Berths and Anchorages: Pacific Cultural Studies from Oceania," stating, "the schools and programs of Pacific studies are still small, institutionally speaking, and it is sometimes the case, at least in my experience, *that too few individuals are working in Pacific studies to make a concerted effort toward institutional change"* (2016, 135).

This comes back to Teresia Teaiwa's *applicability* value in Pacific Island Studies research. Kānaka Maoli scholar Manulani Meyer supports this sentiment with the quote, "Function is vital with regard to knowing something" (2014, 154). Knowledge is not produced so it can sit on a bookshelf or in a library. Instead, knowledge serves a purpose. My intention of conducting research on resiliency to flooding in Papeno'o is applicable, that is a driving factor in why I am producing this research.

Taking these two disciplines, Urban Planning and Pacific Island Studies to examine the subject matter of watershed management and resiliency in Papeno'o Valley is also inspired by Mā'ohi poet, Henri Hiro. In an interview conducted in the 80's, the poet spoke on the future of Tahiti Nui, as it is colonized by France. He examined how Mā'ohi culture could adapt with European culture as a positive. He is quoted as saying

> I refuse to think in opposites; even opposite colors are called 'complementary' and produce harmony. These two cultures [European and Mā'ohi] must come together. I think that now we can no longer speak of independence in terms of breaking away, but as sovereignty over

decision making, according to identity and uniqueness of individuals" (Stewart, Mateata-Allain, Mawyer 2006, 78).

In a sense, this is how I am combining Urban Planning and Pacific Island Studies. While on the surface they may seem unrelated and opposite, they can also be combined, taking the methods from each discipline, to complement each other concerning the future of Tahiti Nui. This is my attempt at subverting the methodologies of Urban Planning to work for the community of Papeno'o Valley, so that the people who live there could benefit from this research, making it reflective of their values, not solely values of Western institutions.

For the research with Haururu, I conducted semi-formal interviews with four members concerning the floods of December 2015, and informal talk stories with seven other members along the course of 6 months. These informal talk stories were about the oral histories of Papeno'o valley concerning natural disasters, place names, Mā'ohi ways of living with land and building structures, and information on seasonal changes affecting Papeno'o Valley. I also attended informational workshops on Matari'i-i-Ni'a and celebratory ceremonies for the Fall Solstice and the start of Matari'i-i-Ni'a, all conducted by Haururu in conjunction with other community organizations around Tahiti Nui.

While I was doing research in Papeno'o, my civic engagement was limited to Haururu. I was not able to collect data from Papeno'o residents who were not in Haururu, which is one of the limitations of my research. For this reason, this thesis constitutes as a "scoping" plan, as opposed to a plan with diverse data. Scoping in planning takes a look broad issues of a topic and takes preliminary steps to look at solutions towards those issues. With scoping it is acknowledged that there needs to first be background research done, then continue the research with the background information first gathered (NRCS 2011). This is the purpose of my thesis, as I know that the research done will not end with this thesis, but I will continue to work with Haururu and members of the Papeno'o community as long as they are willing to have me. The issue of resiliency in Papeno'o is not finished with this thesis,

it is just the first steps.

Sabatier Framework

M. Lubell et al (2003, 286) developed a Watershed Framework (also called the Sabatier framework), which guided me in what type of data I needed to collect and how to organize it. This framework identifies the many actors involved in caretaking of a watershed and shows in what ways they work together and, ultimately, how they can most effectively work together. (See Fig. 2.)

For the gathering of research, the Sabatier framework recommends certain processes, which are as follows:

1 - Gather information to understand the context of the area, such as cultural and historical background. This part took place in Hawai‘i, where I could find information through books, articles, and online resources.

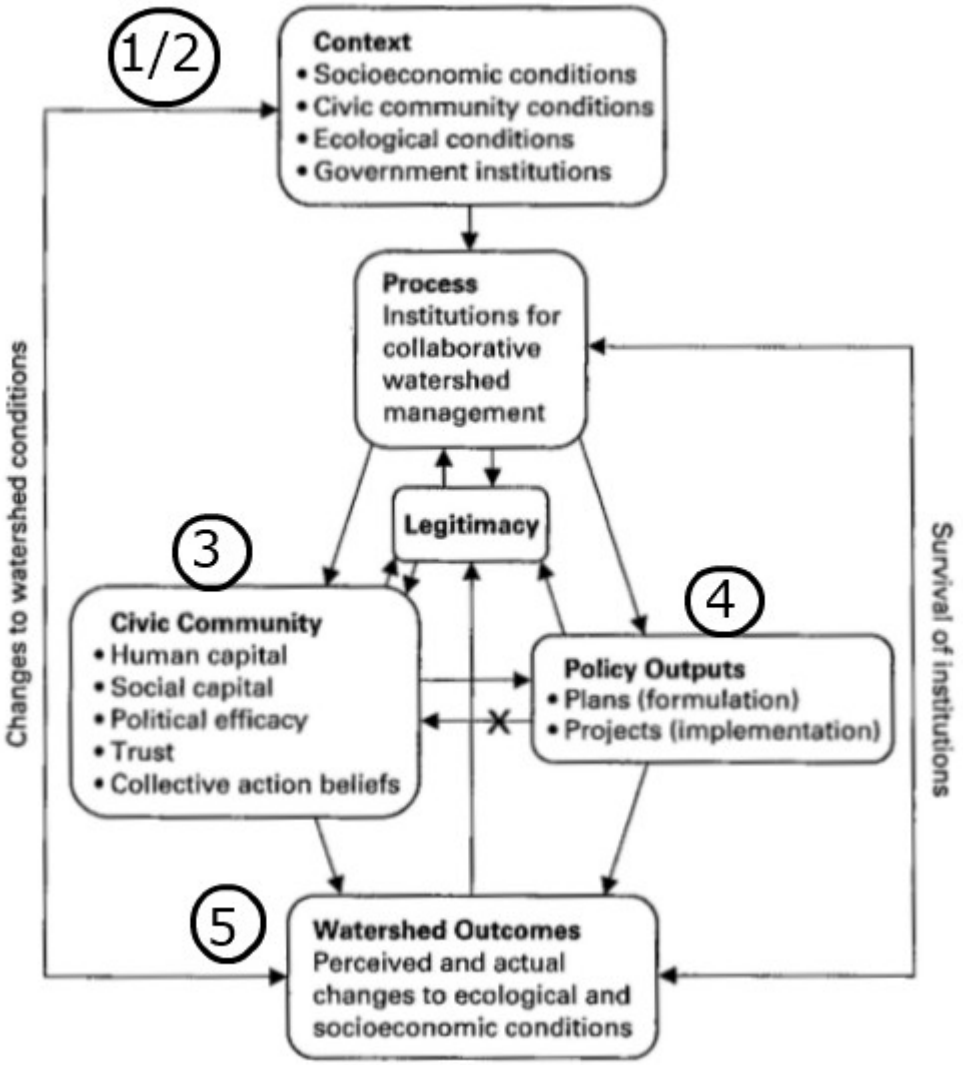
2 - On-site research, which took place in Pape’ete and Papeno’o Valley located on Tahiti island. The research included encountering the civic community (Haururu) and government actors.

3 - Community members of the Papeno’o shared their experiences and expertise of Papeno’o Valley with me. I conducted semi-formal interviews and informal talk stories with members of Haururu.

4 - I interviewed the government actors which are most pertinent to my research - one person from the Service de L’Urbanisme, which is the French Polynesia Department of Planning, who works specifically on Risk Prevention Plans, another person from the Direction De L’Equippement, the French Polynesia Construction Department, and the Mayor of Papeno’o Valley. I also acquired relevant natural disaster plans from the government.

5 - After the gathering of this type of research, I was able to analyze the data for recommendations on Watershed Management Outcomes, the last part of the process.

Fig. 2: The Sabatier framework



(M. Lubell et al. 2003, 286)

Although this was my process to collect and organize the data, these processes are fluid, communicating and reacting with each other constantly. One of the goals of this thesis is to inform how the last part of the process, "Watershed Outcomes," can make its way back to the top of the framework, as depicted with the arrow labeled, "Changes to Watershed Conditions." The end goal is to add to existing knowledge of how to create stronger resiliency against flooding for the civic community

in Watershed Management.

In organizing this thesis, I wrote chapters that roughly follow the structure of the Sabatier framework.

Chapter 1 explains the context of history and culture in Papeno'o, including how Mā'ohi communities settled the valley of Papeno'o and social structures before Western contact and colonization in the 1890s. I will give the context of weather through the history of Matari'i-i-Ni'a as Papeno'o has always experienced strong rains during the Matari'i-i-Ni'a. Then, how Papeno'o Valley has changed over time from housing at the bottom of the valley to permanent housing. And lastly, how climate change will affect the east side of Tahiti by increasing rain and potentially increasing flooding over the years

Chapter 2 summarizes the flooding of 2015 and the effects on the community, which again provides context on how Papeno'o is affected by rain. I then explore how the civic community responded to these issues. I also explore government reactions to the flooding, and preparation for the future in resiliency.

Chapter 3 analyzes the data collected and explores questions and recommendations that would further prepare Papeno'o for resiliency. The recommendations are to better understand cultural context, how policies can aid in resiliency, and how design methods could aid Papeno'o in resiliency.

Chapter 1: Papeno'o: Historical Context and Setting

The area of Papeno'o has a rich history. Understanding the history of this place gives insight to present-day social and physical dynamics. This chapter will review a profile of Papeno'o before Western contact and move through major events in the valley that significantly changed the social and cultural structures of Papeno'o. The chapter will end with the valley as it exists today in terms of population, weather, and other factors.

History and Profile of Papeno'o Valley

Papeno'o residents of today maintain strong oral histories of their valley, as they are genealogically connected to this specific land. There have also been records of this valley by such as historians such as Teuira Henry, William Ellis, James Morrison and contemporary historian Charles Manutahi. Before the Papeno'o dams were built in the 1990's, there were many archaeological studies conducted to determine the cultural impacts of their construction. I've used reports by archaeologists Orliac and Eddowes. There are also ethnographic studies done by the Service de la Culture, the Department of Culture for the French Polynesia government, which are used to report cultural events and history of the valley and are produced for the Service de la Culture's journal, Hiro'a. The information gathered about Papeno'o in this thesis is a combination of historical and scholarly records and the oral histories that have been shared with me through this research.

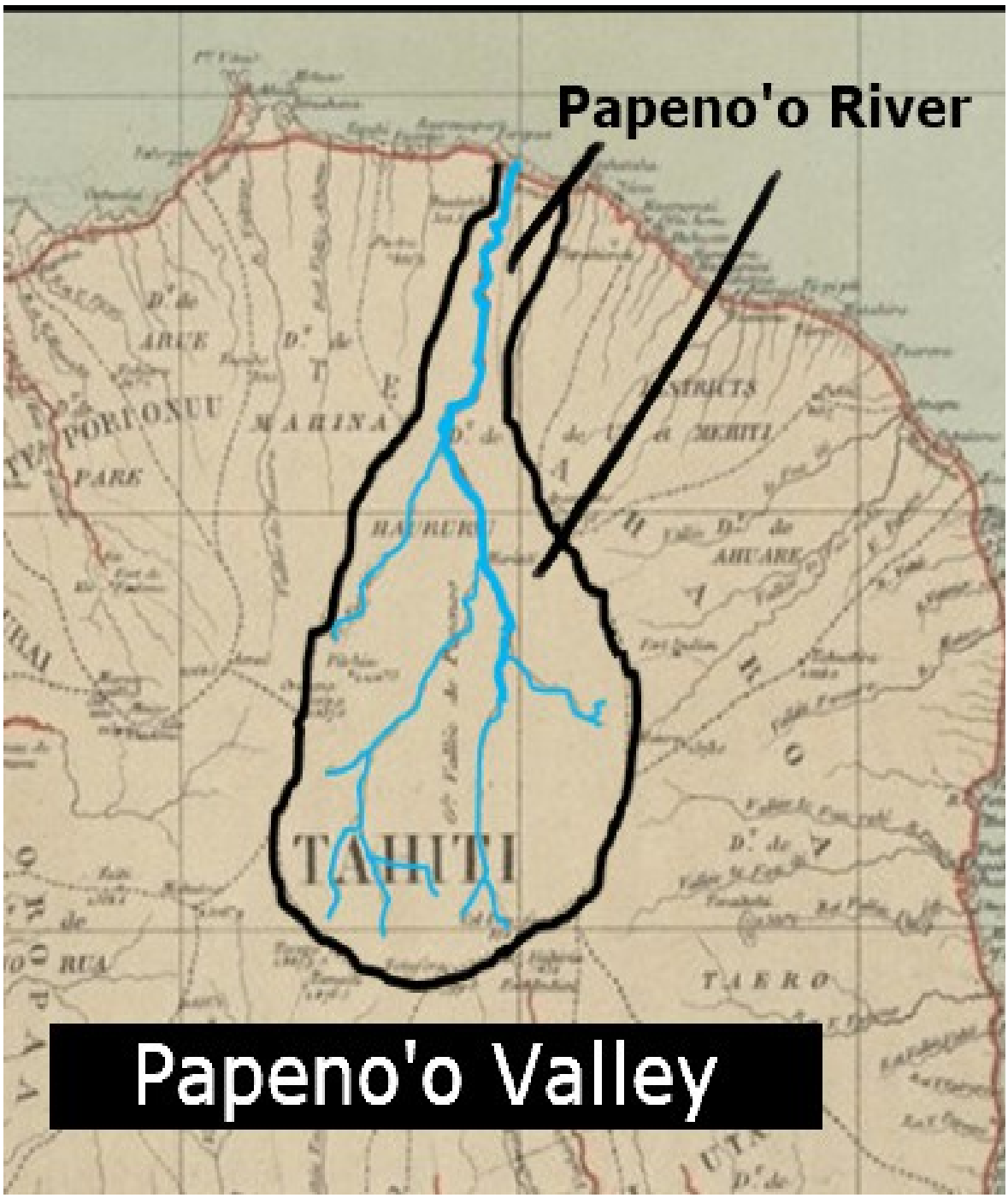
The area of Papeno'o is the largest valley of all Tahiti Nui, meaning the largest valley of the total 118 islands. This valley is recorded as being the most populated of Tahiti before the arrival of Europeans (Hiro'a 2009, 14-17). Because of its immense size, Papeno'o is the largest watershed on the island. It measures an area of 90 square kilometers, while the second largest watershed is in Vaitepiha

Valley and covers an area of scarcely 35 square kilometers (Helm 2017).

Knowledge of this important watershed is encoded in Mā'ohi place names. Historically, the valley has been referred to as Ha'apai'ano – which means "the gathering of all waters." The current name of Papeno'o is understood as Pape – "water" and No'o – "confluent," translating to "confluent waters," "confluence of waters," or "water's confluence" (Hiro'a 2008, 20-21; Henry 2004, 80). These names point to how the valley has always been recognized for the strong flows of water which occur there.

The rivers of Papeno'o start from the top of the valley, formed by the snow that drips from the highest mountain on Tahiti – Mount Orohena. While these rivers are formed by the snow, the annual rain contributes to the waterflow. The rivers throughout the valley flow and gather towards the middle of the valley, contributing to the largest river, Papeno'o River. Fig. 3 displays Papeno'o Valley. Outlined in blue are the smaller, surrounding rivers that meet in the middle of the valley to form Papeno'o River.

Fig. 3: Map of Papeno’o Valley, with streams and rivers outlined in blue



(Helm 2017)

Papeno'o River has historically been referred to as "Vaituaru [. . .] 'the course water that destroys everything on its passage,'" which demonstrates that this river has been known to be very strong and damaging.

These historical place names give insight to geography and disaster of Papeno'o Valley throughout time. These names show the potential power of the river and how areas can be affected, even today. These place names should be taken seriously as knowledge to indicate the river's strong flows, and to indicated the most potentially dangerous areas (Hiro'a 2008, 20-21). Fig. 4 is a real-life photo of the river, showing how wide and large it is.

Fig. 4: Photo of Papeno'o River

(Hacking 2003)

Papeno'o Before Western Contact

Because of Papeno'o Valley's richness in water, it was in turn very rich in terms of agriculture, aquaculture, and wild animals (Hiro'a 2008, 20-21). Wild goats and hogs roamed the valley, and the rivers were full of puhi and 'oura (eels and shrimp). Human population was high because of the availability of land, water, and food. Before Western contact in 1767 and up until the 19th century, the valley was referred to as "Te Mano Rahi, 'the 10,000 warriors,' because of its population," confirming the large population that existed there (Hiro'a 2008, 20-21).

According to historian Charles Manu-Tahi (1997, 8), Papeno'o Valley or Ha'apai'ano had three major geographic areas during the time of Chief Paitai, dated around 1797. As shown in Fig. 5 these areas were Te Papa I Ni'a, the high valley; Te Papa I Raro, the middle valley; and Te Papa I Tahatai, the area closest to the beach and ocean.

Within these areas were numerous large and small settlements called mataeina'a iti. Some of these settlements were permanent, and some were semi-permanent chiefdoms. While these settlements were in place, there was continuous migration in and out of Papeno'o Valley from outside islands. During the time of Chief Paitai, Te Pape I Ni'a and Te Papa I Raro were used as a site of refuge and an area of retreat during intertribal wars (Eddowes 2001, 54).

Concerning the semi-permanent and permanent settlements, the makeup of a settlement is shown best in Fig. 7. In general, agricultural areas were laid out on the lower terraces, closest to the rivers for waterflow. These areas are labeled H for Horticulture in Fig. 7. The agricultural terraces would be separated from the river by a wall and a distance of at least 75 meters (242 feet) (Orliac 1989, 17; Haururu, CPSH).

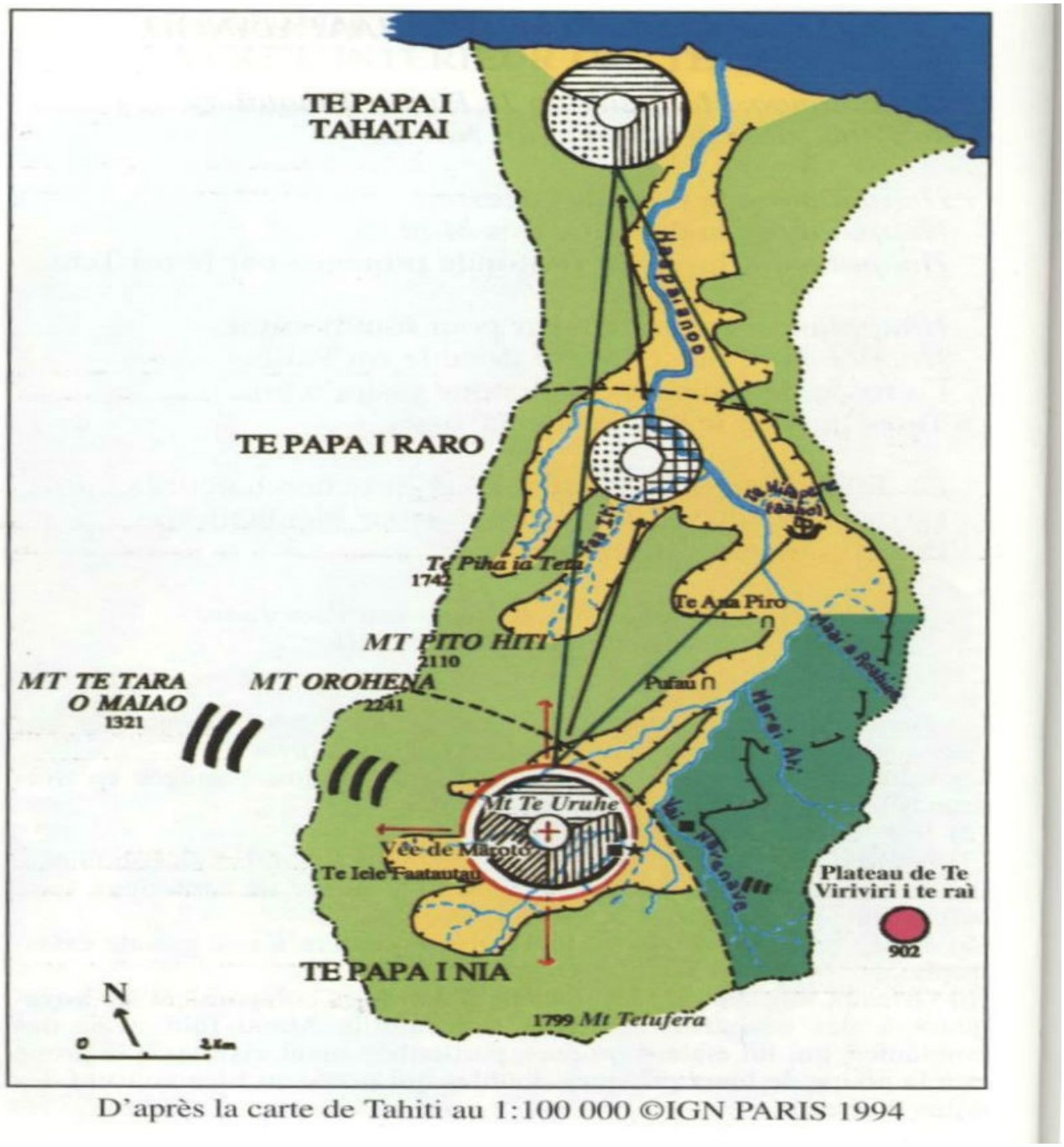
Living areas were on the higher terraces, well protected from floods, usually near a creek or a spring. These living areas were organized by a concept known as the 'utuāfare, which are several

houses clustered in one general area. In Fig. 7, one can see several F, marked for Fare, in a cluster. Each fare served a different purpose, as several different behaviors in life needed different fare. For example, men and women had different sleeping houses, and there were different houses to make food and to eat food (Morrison 2003,164; Haururu, CPSH). Lastly, Fig. 7 shows M, which stand for marae, the sacred temples of the settlements. The marae are built at the extremes of the village, at the highest terrace.

The marae that Haururu cares for, Fare Hape which is located in Te Papa I Ni'a, is identified by caretakers to be a semi-permanent settlement. Fare Hape has the exact same layout of 'utuāfare, horticulture areas and irrigated rivers as explained above. Fare Hape also experiences flooding, so it was unlikely that this was a permanent settlement (2017). In general, there was much movement between neighbors and mataeina'a iti, such as Fa'aripo and Ha'apaiano'o. This is evidenced by the many paths in the valley which connected the areas (Eddowes 2001, 54).

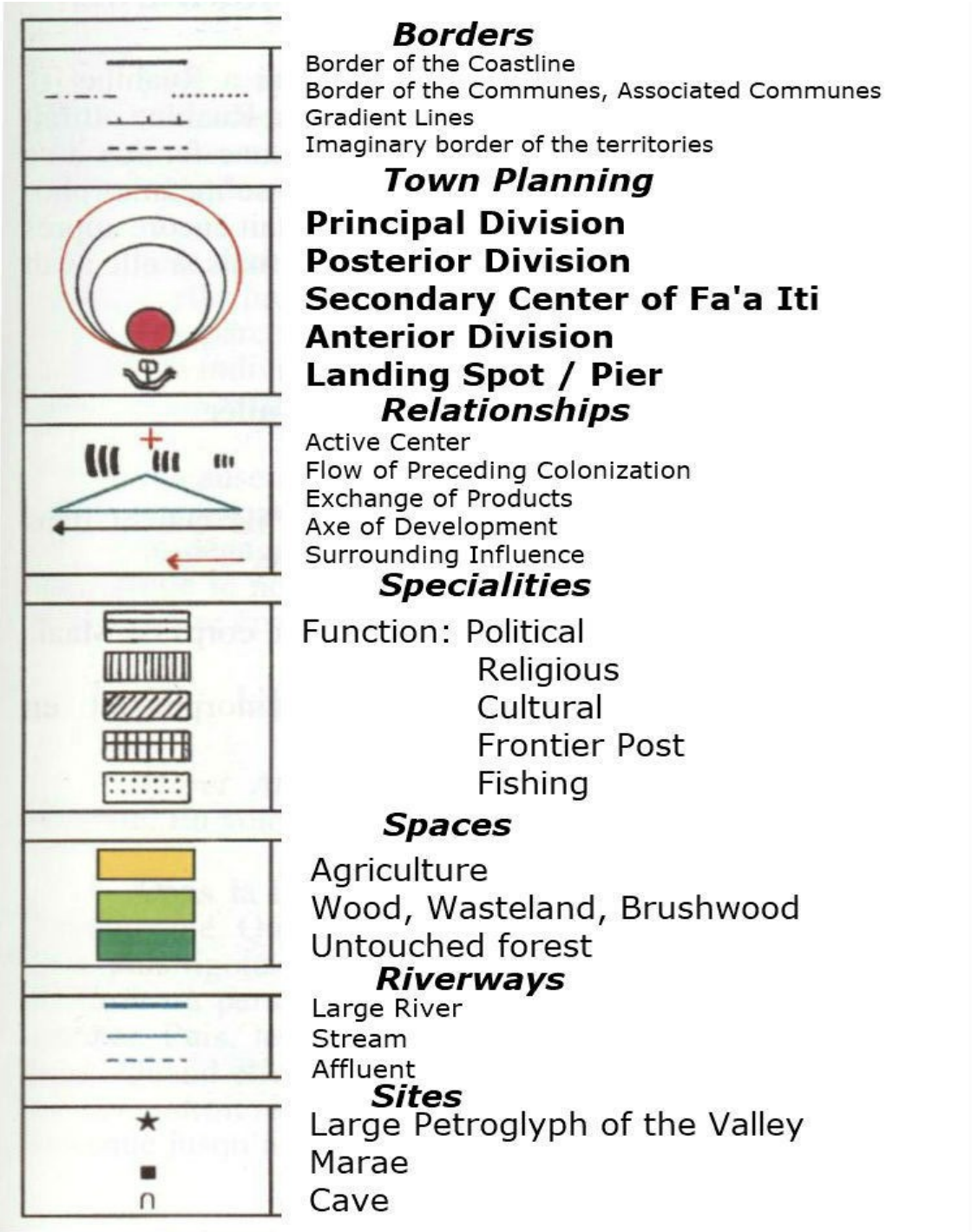
This historical explanation of Papeno'o Valley is to show that while Papeno'o continuously had the largest population of Tahiti Island, the mataeina'a and people were able to maintain and sustain themselves through high population numbers, continuous movement, and adjustments to weather and the heavy rains of Matari'i-i-Ni'a.

Fig. 5: Map of Papeno'o Valley in 1797



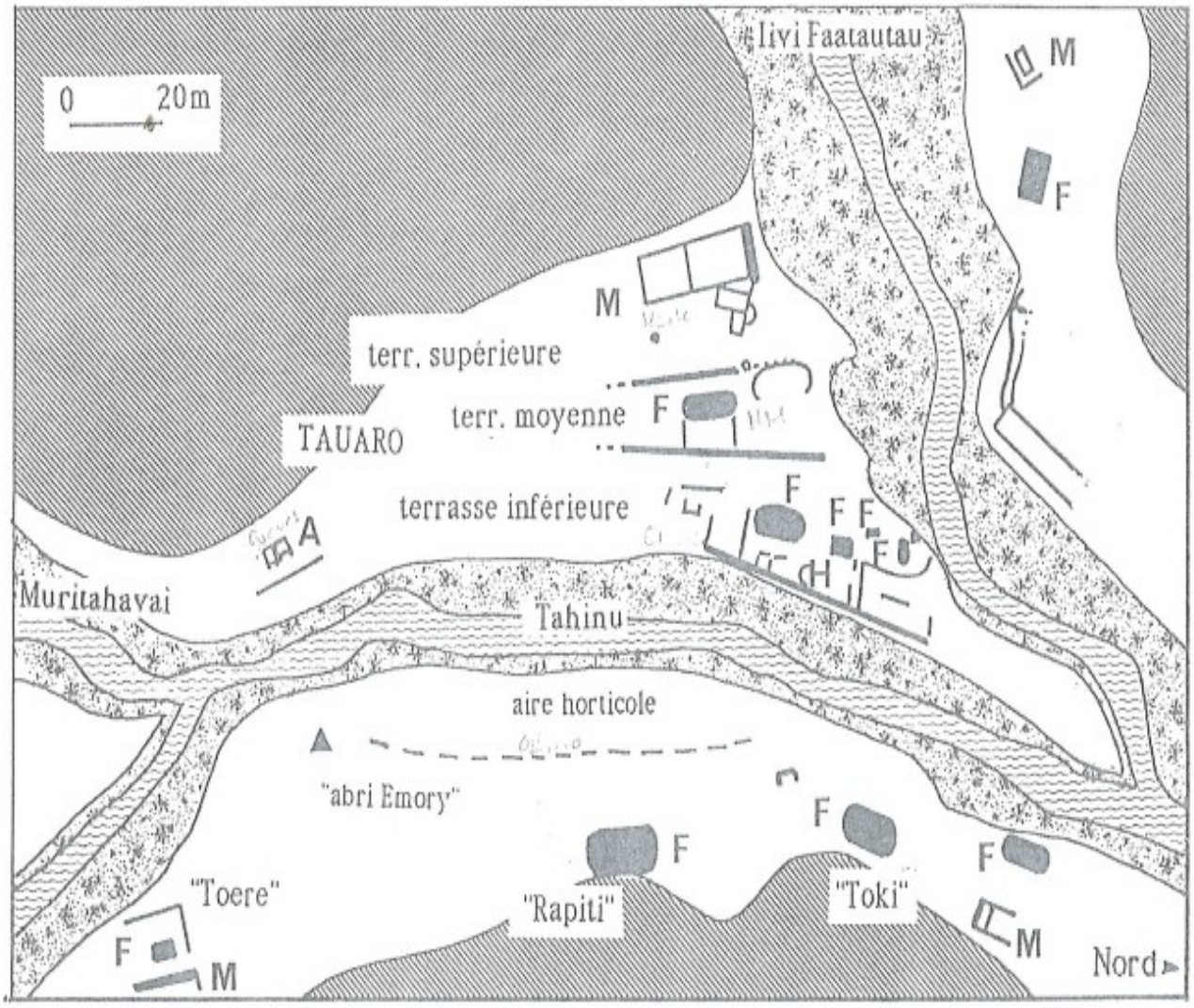
(Manu Tahi 1997, 8)

Fig. 6: Legend for Map of Papeno'o Valley in 1797



(Manu Tahi 1997, 9)

Fig. 7: Settlements of Te Papa I Raro, Papeno'o Valley



Legend: M – Marae (sacred temples located on the highest level of land); F – Fare (houses, located on the middle level of land); H – Horticulture (located closest to the river); A – Archery platforms. (Orliac 1989, 17)

Te Mau Mata'i, Maraamu and Matari'i-i-Ni'a/Matari'i-i-Raro

Knowledge of the seasons and environment were deep in Mā'ohi culture. Historically, the population lived off the land, and the ability to sustain one's self and community is through the understanding of seasons as they relate to agriculture and aquacultural changes (Ellis 1972, 77).

In Tahiti, Mā'ohi communities historically used environmental changes throughout the year to indicate days, nights and months. Astronomy played a large role in signifying changes in the Mā'ohi year, called matahiti. There were twelve or thirteen lunar months in the matahiti and there would be two significant overall changes indicated by astronomy and star constellations. By following the Matari'i, or Pleiades star constellation as it is known in Western culture, Mā'ohi culture divided life into a wet season, called Matari'i-i-Ni'a and a dry season, called Matari'i-i-Raro. During the time of Matari'i-i-Raro, after the sun sets, the Pleiades star constellation is not visible in the sky and environmentally there is less rain, less food, and it is a time for work in general (Henry 2004, 80; Ellis 1972, 77; Hiro'a, 2008).

Haururu members have written songs about this season as of recently, indicating what changes occur to land and life. As seen below, the authors speak of a time for more restrictions, a time to learn and prepare the land, and the gods are not present.

MATARI'I-I-RARO

Ua faaite o Matarii i raro	Matarii raro has shown us
Te tomo nei tatou	That we have entered
I roto i te tau oè	In the time of restrictions
E tau teie no te haapiiraa	It is the time of teachings
E tau no te faaineine te fenua	The time of preparing the land

Ua huri te tau ta'oto te fenua	The time has changed, the land sleeps
Ua iti te mau mā'a ato'a	The food is of little abundance
E tau teie no te taraniraa	It is the time of restrictions
E tau no te rahuiraa	The time of the rahui
Ua ho'i te nuù atua	The gods have returned
Ua ho'i i te pô	Returned to the po
A faatura	We have respect

(Calmélito-Heifara 2017)

November 20 marks the start of the Matari'i-i-Ni'a, when the Pleiades star constellation rises when the sun sets. This seasons lasts until about February. With it's commencement comes the celebration of the god 'Oro, who is the god of fine arts. In other times, 'Oro is the god of war. But because the Matari'i-i-Ni'a season is a time of peace,'Oro transforms to a more peaceful god accordingly.

These celebrations occur to welcome the gods and the abundance that comes with them. There is an abundance of heavy rains, and therefore food and agriculture. This is a time of rest and play because the heavy rains do not permit long hours of working the land. Cultural activities are also abundant during this time as well (Henry 2004, 339; Ellis 1972, 77; Hiro'a, 2008; Davies 1984, 138).

In Western scientific terms, the rain increases during December to February due to the activity of the South Pacific Convergence Zone (SPCZ), known commonly as the "Trade Winds Front." As Helm (2017) describes,

> This is the confluence between the northeast trade winds (hot and humid) under the influence of the Anticyclone of Easter Island and the southeast trade winds (fresh and dry) commonly known as "Maraamu" in Mā'ohi culture (Davies 1984, 133). Tropical depressions are formed at this

level of convergence zone. Due to the dominance of the northeast trade winds, the east coast of Tahiti has a significantly higher annual rainfall (3500 mm/yr) than the west coast (1500 mm/yr). During this time of Matari'i-i-Ni'a, Papeno'o Valley experiences heavy rains because it is located on the eastern end of Tahiti island. The average water height of precipitation is 6600 mm/year in the upper valley, 4800 mm/year in the middle valley and decreases to 3500 mm/yr in the lower valley (Danloux 1997). Matari'i-i-Ni'a is significant because this is the season when Papeno'o is threatened by heavy rainfalls, and potential flooding. The flooding of December 2015 was during Matari'i-i-Ni'a (Inondations 2015; Sinistrés de la côte Est 2015). In contrast, Matari'i-i-Raro (the dry season) is an opportune time to plan and carry out adaptation and resiliency methods to prepare for the rainy season.

1800s Papeno'o to Present-Day Papeno'o

Papeno'o Valley and Tahiti in general have undergone changes to environment and culture in the last 200 years, due to numerous factors after contact with the West. These changes have heavily influenced how people in the valley relate to land, and how they adapt to seasonal changes such as Matari'i-i-Ni'a.

Land Division

Historically, land was a strong part of identity for Mā'ohi people. Haururu member and cultural practitioner, Papa Heifara, links his genealogy to come from Papeno'o for generations. He continually states in conversation that his identity involves oneness with the land and, that land is not separate from who he is. For him, the land is his pito (the umbilical cord which connects a person to their mother), and he sees his own self as the land, as the environment with Papeno'o Valley. It is very important to note that in Mā'ohi culture, there is not a separation between bodies, land, and environment, but a deep and integrated connection.

In *Entre Nature et Culture,* ethnographer Bruno Saura describes how the identity of oneness with land starts even before birth for Mā'ohi people. He explains that people refer to the placenta of a fetus as the pūfenua, which translates to "core of the land." The very way in which Mā'ohi bodies are formed is through, in conjunction with, and within the land, which again signifies this important connection. After birth, these same placentas are buried into the familial land, therefore connecting the fenua (land) with the pūfenua, and solidfying a lifetime of oneness together (2005, 37). These ideas of land, identity and culture as one are continually affirmed by many different authors and cultural practitioners (Kahn 2000, 10; Raapoto 1994; Rigo 2016).

During the time of the Ari'i, land was commonly shared by families in the mataeina'a iti, under a system in which resources, such as food and water were also communal (Kahn 2000, 10; Tetiarahi 1987, 47-48). With the introduction of Christian and Western values by missionaries from the London Missionary Society (LMS), ideas about land tenure arrived that differed from these communal lifestyles (Levy 1973). These Western values and ideas were exchanged with Mā'ohi communities, but changes to lifestyle did not occur instantaneously, but rather as an accumulation of many events over a number of decades.

European contact with Tahiti came in 1767 with Captain Wallis, followed by Captain James Cook, then numerous explorers, traders and missionaries of differing countries such as Britain and Spain, followed (Newbury 1951, 1-10). With these contacts and exchanges, there came alliances between Mā'ohi Ari'i and Westerners. One of the most notable was the collaboration of the LMS missionaries and the Pōmare dynasty, an Ari'i family who lived on the Eastern side of Tahiti. The LMS missionaries and the Pōmare family were able to create a centralized Christian State, an absolute monarchy, after this alliance had won a battle of varying Ari'i on Tahiti island, called the Battle of Fē'ī Pī in 1815. After this centralization, there was a written code published in 1819 called the Pōmare

code. This code contained laws that reflected Western values such as the restriction of "theft, adultery, murder, bigamy, rebellion and sedition" (Gonschor 2008, 33; Newbury 1980, 51).

With the LMS missionaries came ideas of a nuclear family lifestyle, as opposed to the Mā'ohi ideas of the 'utuāfare - the communal family lifestyle (Levy 1973, 204-205; Kahn 2000, 10). In 1852 families began to divide land between themselves and register the land into family titles called Depliant Tomite. When Tahiti became annexed by France, the Depliant Tomite continued to be honored and local jurisdiction over land stayed in Tahiti. In 1902 land that was not claimed by the Depliant Tomite then became property of the French Polynesian government. Land divisions have been a contentious issue since the Depliant Tomite. For example, in 1913 land dispute claims rose to 21,000 court cases (Newbury 1980; Tetiarahi 1988, 105). Today these same land titles continue to be recognized by the Direction of Land Affairs of the French Polynesia government (Direction Affaires Fonciers, 1).

The identity of Mā'ohi people, land and environment as oneness is not completely gone in Tahiti, but rather exists within new circumstances of a combination of history, Western law and Western social structures. Legal anthropologist Tamatoa Bambridge has written extensively on the "pluralistic society" which exists today in Tahiti Nui due to the convergence of Western influence and Mā'ohi culture (Bambridge 2012). He uses the definition by Griffith who defines this pluralism as 'the coexistence within a social group of legal orders that do not belong to a single "system"' (Griffith 1986). In "Land and Marine Tenure in French Polynesia: A Case Study of Teahupo'o," Bambridge summarizes how Mā'ohi people, even with the influence of law and private property, still maintain their communal lifestyles, and oneness as it relates to genealogical land, in certain ways:

> In such a context, the territory does not appear as a succession of private properties, independent of each other, in which the only issue would be "the organization of living together," of a group of individuals with divergent interests. On the contrary, the territory

resembles a kinship and land network whose borders are mobile and permeable within the framework of this same network. (Bambridge 2012, 128-130).

While historically Papeno'o has been occupied from Te Papa I Ni'a until Te Papa I Tahatai (Fig. 5), with the influence of missionaries and European lifestyles, Mā'ohi people left Te Papa I Ni'a to move towards the coast. Population also started to decline during this time because of Western diseases, which decimated the population by 8 to 14 times. By 1850, the high and middle valley of Papeno'o were empty (Haururu N.D., 4).

The coast of Papeno'o has been occupied since, and families along the coast registered their family land with the Depliant Tomite. Because of this history, the population of Papeno'o continues to occupy the coast, many continue to live on family land, and there are historical and familial connections between Papeno'o community members.

Population and Government Today

The 2012 census carried out by the Institute of Statistics of French Polynesia (ISPF), estimates the population of Papeno'o at 3,766 inhabitants, which is a drastic drop in population numbers since the time of Chief Paitai. In terms of population density, this represents about less than 332 inhabitants per square kilometer. Less than 8% of the total population of the commune was born outside the territory meaning that many Papeno'o residents today are Mā'ohi. In general, migrants from outside the territory are people from France, working as teachers or soldiers (Challier & Ye 2013).

The population of Papeno'o continues to be concentrated towards the lower valley, near the coast and along the main road, which runs through Papeno'o and around the island. The population along the coast is surrounded by the presence of the the town hall, the shops, the only primary school (no middle school or high school), the football stadium for sports activities, the Protestant church, the Catholic Church, the Center for Young Adolescents (CJA), and a cultural center (Tepava et al. 2014, 2).

There are religious groups and secular organizations present in Papeno'o Valley. Haururu is one group that consists of cultural practitioners and caretakers of Fare Hape (Personal interview).

Local government issues are handled by the elected Mayor of the valley, who works at the only City Hall present in Papeno'o. This City Hall is an associated commune (under the larger commune) of Hitia'a O Te Ra, which takes up the east side of Tahiti island (Avaemai 2017, personal interview). The entire commune of Hitia'a O Te Ra was affected by the rains of December 2015. The commune of Papeno'o works closely with the larger Hitia'a O Te Ra Commune in many governmental aspects, including responses and long-term resiliency actions to natural disasters.

The socio-economic categories of Papeno'o can be divided into three sectors of professional activity: the primary sector comprising basic trades and resource extraction trades such as agriculture, fishing, mining activities, etc. The secondary sector is comprised of industry-related trades such as the work of converting primary resources into manufactured goods. Lastly, the tertiary sector essentially consists of services, such as education, defence, etc.

In 2012 there were 12 farmers in the commune. In the same time period, the Artisanal industry and small businesses represent together less than 9.3% of the working population employed. Executives and intermediate professionals were less than 16.6% of the working population in 2007, but by 2012, this category had gone up to 25.1% of the working population.

The primary sector (comprising of agriculture and basic trades) of Papeno'o is under-represented with the number of farmers being very small despite the potential agricultural development of the area. The secondary sector is better represented with a majority of the population working in the working-class. With the tertiary sector, there has been a great increase in the proportion of managers and professionals in the commune (Tepava et al. 2014, 2).

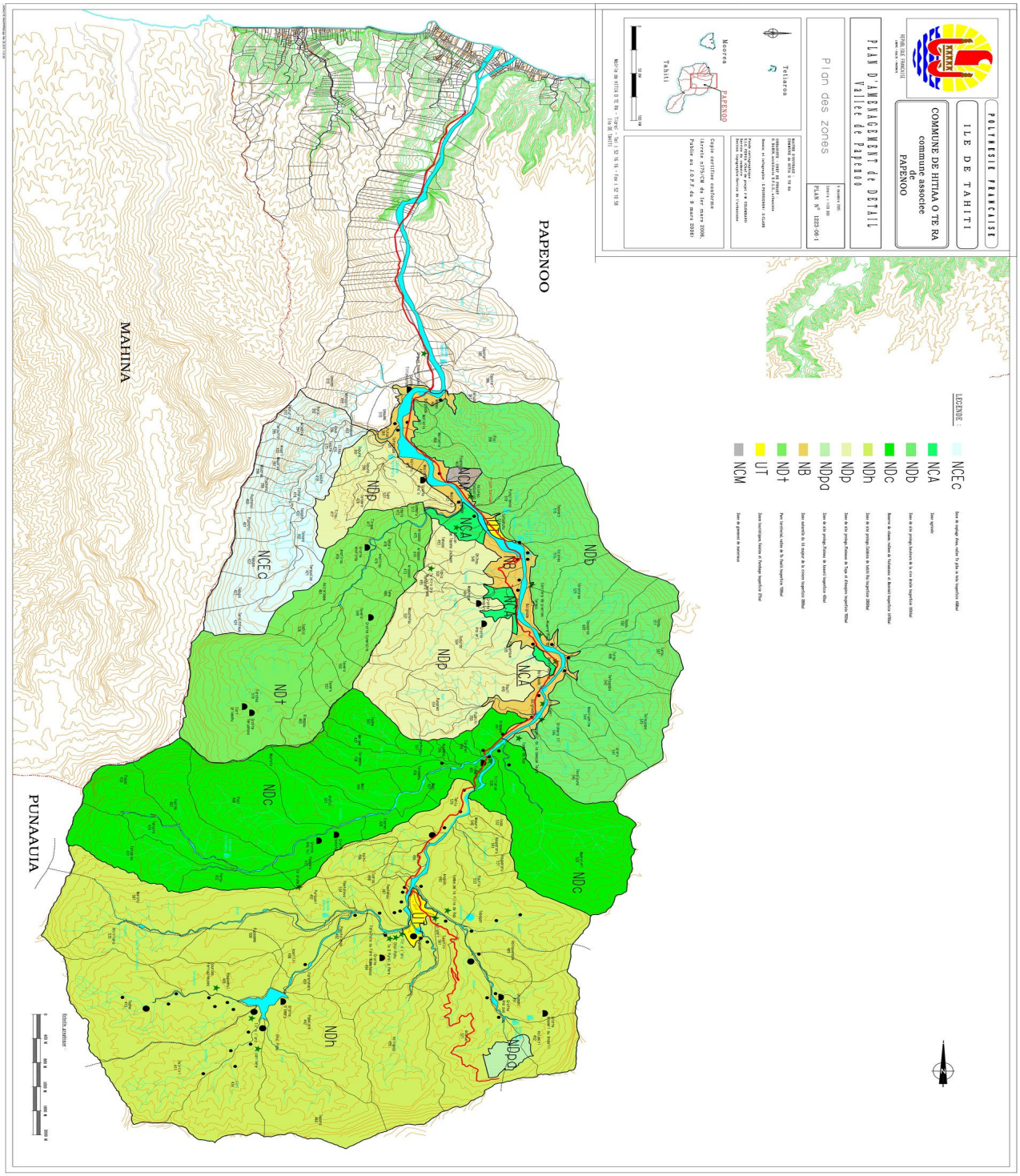
This information on employment helps to describe the socioeconomic capabilities of the community in their response to natural disasters. It also points out which government agencies handle

natural disaster issues and who are the groups in Papeno'o who can organize to respond to natural disasters.

Plan D'Amenagement de Detail (PAD)

On March 1, 2006, the municipality of Papeno'o set up a PAD (detailed Plan) for Papeno'o Valley specifying the regulations and zoning in this valley (Fig. 8) (PPR 2017, 15). The PAD separates the valley into several areas, with the upper valley of Papeno'o being zoned as different natural areas and the lower valley as occupied by private property and housing. The upper valley, Te Papa I Ni'a, is separated into respective zones designated agriculture, hunting areas, protected areas, protected river and landslide areas, touristic zones, and a public park. The population of Papeno'o Valley is concentrated towards the lower valley, next to the river mouth and the coast. This thesis focuses on how weather affects the housing and population located towards the bottom of the valley – Te Papa I Raro.

Fig. 8: Map of Zones for Papeno'o Valley



(PPR 2017, 15)

Climate Change and Consequences

Modern day circumstances force us to consider the issues and concern over climate and weather, which could have severe impacts on Tahiti Nui and Papeno'o Valley. Scientific evidence suggests that the Earth's climate is changing which will affect Pacific Islands by a variety of issues concerning sea level rise, unpredictable precipitation patterns, increased heat, among other extremes (IPCC 2014).

With islands in the Pacific being so vulnerable to, it is important to prepare for worst case scenarios concerning natural disaster and climate change. This thesis is an attempt to engage with the land and future of Papeno'o, because this area is at a high risk when it comes to rains and flooding.

Climate Change in Tahiti Nui and Papeno'o

Tahiti Nui, like the rest of the Pacific, is expected to experience extreme weather patterns in the upcoming years. The Direction de L'Environnement sector of the French Polynesia government is very engaged with the phenomena of climate change and has produced literature concerning climate change in Tahiti Nui. Two important pieces of literature produced by the Direction are: The Strategic Plan for Climate Change, in 2012 and The State of Climate Change in 2009. These two books explain in detail the predicted weather patterns of the next 100 years.

This thesis focuses on the issue of intense rainfall, which could cause the flooding of crops, streams, rivers, and loss of homes (Avagliano & Petit 2009, 57; Lallemont-Moe 2015, 58). In Papeno'o Valley currently, there is intense rainfall that occurs during the Matari'i-i-Ni'a, which is November 20 to February.

The Service of Urban Planning of the French Polynesian government has produced a study concerning flooding in Papeno'o Valley, which predicts flood zone areas in the next 2, 10, 50, and 100

years.

Fig. 9 shows a flood zone risk map that was documented in 2006 on the right-hand side. The map on the left-hand side shows the flood zone risks predicted in 100 years (2017, 10).

For each map the red zones identify areas that are very high risk, yellow marks areas that are high risk, green marks areas that are medium risk, and blue marks areas that are low risk, while white is not calculated or no risk at all. The risk areas are calculated using information about the height of floods and the speed of waterflow in a 100-year floodplain.

As one can see when comparing the two maps, the 100-year prediction shows an increase in areas with very high risk of floods (red zones). These areas are currently occupied by residents in Papeno'o and are predicted to be occupied in the future, indicating a problem for human safety.

Fig. 9: Map of Flood Zones in Papeno'o Valley

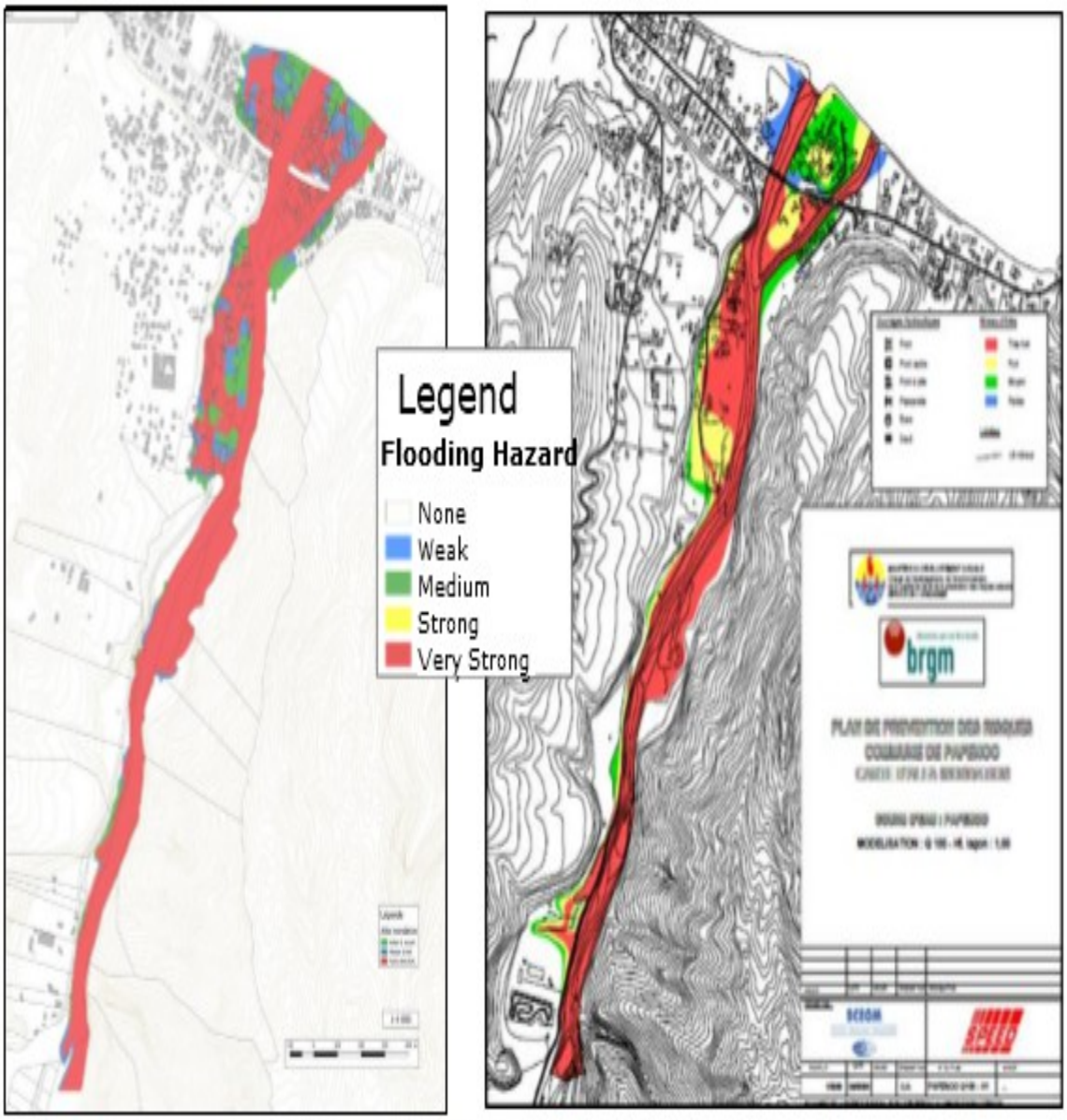


Figure 23 : Comparaison de l'aléa inondation avec l'aléa déterminé en 2006

The left map is estimated flood zones in Papeno'o in 100 years; the right map is flood zones of 2006. (PPR 2017, 53)

Conclusion

In an attempt to understand the current day situation of Papeno'o Valley, I have outlined the most significant historical and present-day influences. Although many changes in land use due to Western influence took place in the 19th century, many people of Tahiti strongly identify with the land that they live on because of their genealogy and influencing the communities strong relationship to each other because of the familial history between community members. Furthermore this is the land they have been given according to Tomites filed in the past.

The people of Papeno'o Valley annually experience heavy rainfalls during the time of Matari'i-i-Ni'a. With time, this rainfall is expected to increase and be a hazard for those living in flood zone areas.

In order to prepare the people of Papeno'o for intensified rainfall during Matari'i-i-Ni'a, this remaining chapters of this thesis will explore how the people of Papeno'o have responded to previous flooding, how the government has responded to previous flooding, and ways they can work together better for resiliency.

Chapter 2: Flooding and Community and Agency Responses

The research focuses on the heavy rains and flooding of Saturday, December 12, 2015 that affected Papeno'o Valley. This was during the season of Matari'i-i-Ni'a, where constant rain happens for months and especially in December, January and February. Two areas of Papeno'o Valley were particularly affected: Fa'aripo and Rape (Inondations : à Faaripo, 2015; Sinistrés de la côte Est, 2015).

Because of the geography of Tahiti island, rainfall can be torrential and cause rivers to have torrential characteristics (Helm, 2017). Torrential downpours are extreme heavy rains which occur at one time. As Helm (2017) describes,

> The relief [the geographical difference between the highest and lowest points] of the island cause gatherings of warm air at the mountaintops. When coupled with the highly-constrained form of the Tahitian valleys and low soil infiltration, this has the effect of giving a torrential character to the rivers. The hydraulic regime is therefore related to precipitation. The strongest known [river] flows are the highest in windy valleys where they can achieve phenomenal values. These record floods are fortunately quite rare and result from rainy episodes of cyclonic origin. For example, in Papenoo, the average annual module is 13.2 m3/s, while the maximum rate recorded is 1000 m3/s during the year 1982, when there was a cyclonic episode. In 1983, the passage of Cyclone Veena also increased flowrate, with a maximum recorded at 2200 m3/s (ORSTOM, 1993).

While residents of Papeno'o experience heavy rains every year during Matari'i-i-Ni'a, the December 2015 rains and floods were the heaviest they'd experienced in their lifetime which also caused the most damage. In their account, these rains were torrential for reasons unrelated to climate,

but instead related to land management and imposition by outside developers. In their view, a proposed hotel resort in the valley was disrespectful of Tahitian culture and ideas about balance with nature. This resort, called Ecoparc, would have been a recreational add-on to an existing hotel, with tourist attractions such as zip-lining. To some, this caused the "land to react angrily" to the proposal of a hotel and sale of the land, and therefore the rains were a reaction to this hotel (community members of Papeno'o, personal conversation 2017). Currently, the construction for this resort has been placed on hold due to reasons unknown to myself.

The reasoning for flooding given by Haururu community members may indicate that in order for rains during Matari'i-i-Ni'a to be tame, it is important to respect the land, and not use it for profit or have outsiders determine the use of land in the valley. This line of thinking is congruent with how Haururu first started, as the community members came together to protest the construction of several dams in the valley. There is a considerable amount of respect that Papeno'o community holds for their surroundings.

In interviews with community members and through online news articles from TNTV and Polynésie 1ère, information was gathered about the events that happened on December 12, 2015 and up to months after the flooding. The rain started around 9AM and lasted until 11:30 AM on December 12, 2015. It came from deep inside the valley of Papeno'o and lasted all day and night, with severe damages happening on Saturday and continuing into Sunday. With so much devastation happening on Saturday, the community members of Papeno'o Valley mobilized themselves in any way they could, with government and island-wide aid coming shortly after.

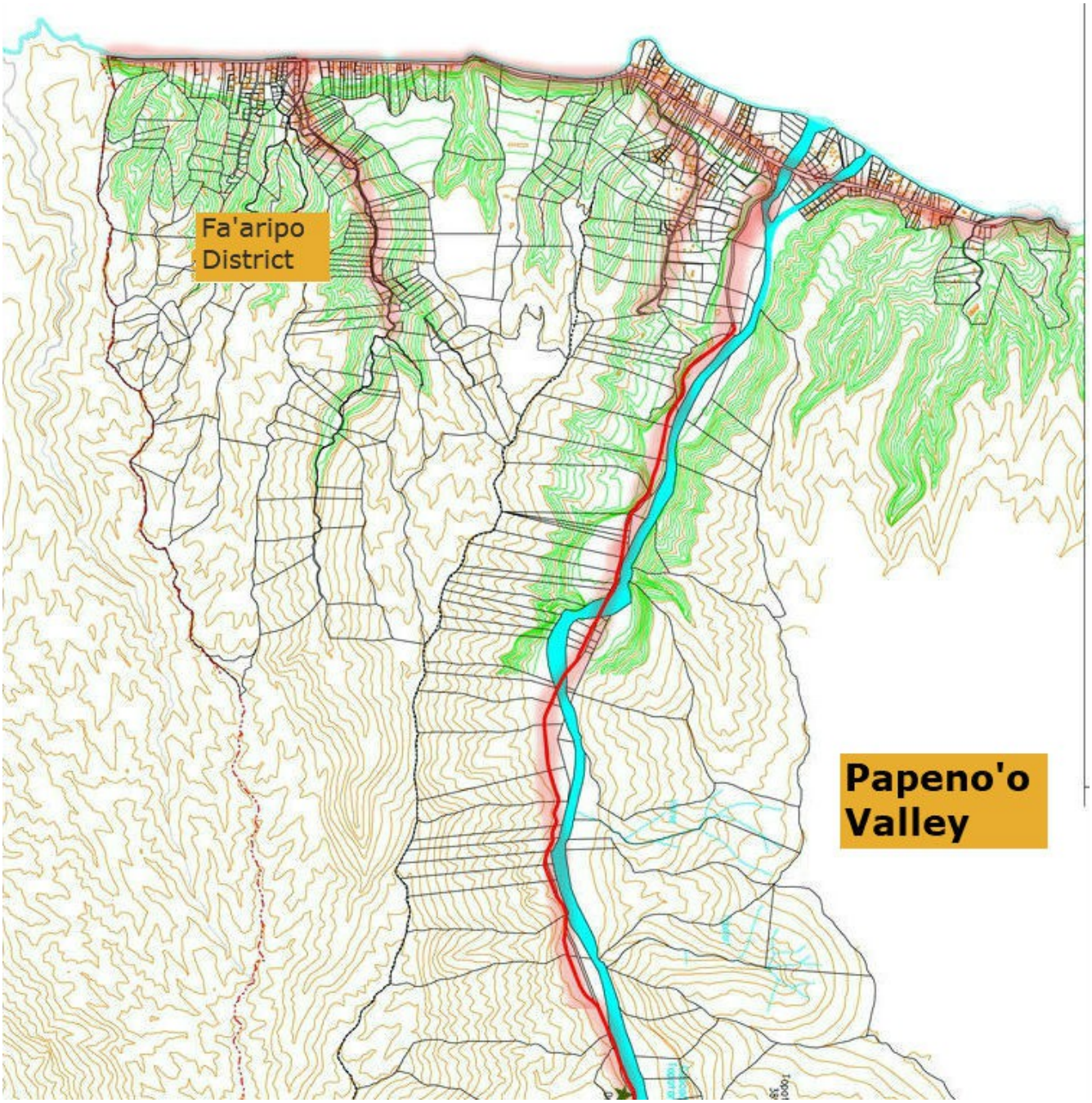
The following day, Sunday December 13, the mayor of Hita'a O Te Ra estimated that almost the entire district of Hitia'a O Te Ra was devastated. At this time, mayor Dauphin Domingo called for island-wide solidarity and mobilization (Inondations : vers un bilan, 2015).

Consequences of Rain and Flooding

During this flooding, there were numerous issues related to health, safety and access to food, water and electricity because of the rain. (Raveino & Lee 2015).

Flooding occured in large and small riverways of Papeno'o, roadways, and other high risk areas where water gathered. Below is a map of affected areas, highlighted in red. They were: the main road located close to the coast; the main road leading into the valley and the district and road of Fa'aripo, located on the right side of Papeno'o valley (Fig. 10).

Fig. 10: Map of Papeno’o areas that were affected by 12/2015 flooding



(SAU 2017)

Roadways

Figure 10 is a picture of a flooded road located in the valley of Papeno'o. There is debris in the road, and the amount of water hinders transportation by car, bike or foot.

For some, the roads prevented access to outside resources, such as food and water, having to depend only on what was available in their houses. Every weekend, a group of caretakers rest at Fare Hape, located 18 kilometers into Papeno'o Valley, travelling via one road in and one road out. On this Saturday, the heavy rainfalls caused the flooding of this road, with no car being able to pass for four days (Vigilance jaune, 2015, Inondations : la côte, 2015).

The flooded roads also inhibited transportation for mutual aid by community members. As one community member recalls, "It was difficult to send out the young people for clean-ups because the road was impossible [to traverse], there was water coming out of the canals and going everywhere." (community member of Papeno'o, personal conversation 2017)

Fig. 11: East Coast, Tahiti 2015: A flooded road in Papeno'o Valley

(Taaviri 2015)

Landslides/Waterfalls

While rain caused flooding in roads and rivers, it also caused waterfalls and landslides in high risk areas. As one resident reported/testified, “I live in Maroto in Papeno’o Valley ... (...) It’s not the river that has overflowed at home, but rather the waterfalls of the plateau that have poured into the neighborhood” (Aide aux sinistres 2015).

Houses

Houses were destroyed in numerous fashions. Some houses were affected by walls and roofs toppling down causing rain and mud to enter the houses, destroying floors and furniture. There were reports of houses where the water drained quickly, while in other houses flood water remained for more than a day because of the lack of proper drainage systems (community member of Papeno’o, personal conversation 2017; Raveino & Lee 2015). Figure 12 and 13 on the following page show two houses that were destroyed because of the rain.

In the destruction of houses, electricity was affected for weeks. As one community leader recalled, “There was also no electricity because all the cable were destroyed, therefore, after that, we sent out our youth to help those in need” (2017).

Fig. 12: East Coast, Tahiti 2015

(“Sinistres: les habitations ne seront pas reconstruites dans zone rouge” 2016)

Fig. 13: East Coast, Tahiti 2015

(“Intemperies:la cote Est” 2016)

Public Health

Due to the flooding, health concerns increased and even one fatality occurred. One of the biggest concerns was the presence of leptospirosis, which was "circulating actively," according to news sources. "This serious, sometimes fatal disease is caused by bacteria (leptospira) that can enter the body during skin contact with mud or dirty water, soiled by the urine of animals (rats, pigs, cows, dogs, …)" (Vigilance jaune, 2015).

For many, clean drinking water was unavailable. Tap water stopped in many houses and there were water shortages for the following days. One resident stated, "The water did not come back quickly. I believe that the pipelines were also affected by the flood. We had help with bottled water, but that was not enough" (Aide aux sinistres 2015). Another noted that "Water is still a problem for the victims of the East Coast, but this time it is drinking water that is lacking. The distribution networks have not been spared by the damage" (Intempéries : les sinistrés manquent 2015).

This amount of damage done to Papeno'o shows how devastated an area can become due to natural disasters. Therefore the issue of flooding should be taken seriously by community members and government and planning must address adaptation and resiliency to this issue.

Immediate Responses

Responses to the flooding were immediate as community members took it upon themselves to mobilize. The responses occurred as the flooding happened, directly after the weekend and up to a month after the flooding, which was needed because of the heavy damage that occurred.

Community Responses

Community responses were strong. Among the responders were individuals, churches, and

small community organizations from the valley.

Patrick Nunn, a geography scholar who studies Pacific Islands, states that churches hold a strong presence and influence in Pacific Islands, and are in strong connection with the communities they serve, which is true in the case of Papeno'o (2017). Below is a chart of the main churches who aided in response to the flooding.

Table 1: Churches who organized response to flooding.

Churches	Responses		
	Call-out to youth for clean-up	Provide Meeting Space/Welcome Space for Families	Donations (clothes/canned goods)
Mormon	x	x	
Protestant	x		x
Catholic	x		
Adventist	x		x

(Personal conversation 2017; Récolte de vêtements, 2015; Aide aux sinistres, 2015)

All churches were strong in calls out to local youth, while the Mormon church was the strongest in providing meeting spaces and welcoming spaces for families. The Protestant church and the Adventist church were stronest in donations for clothes and canned goods. This shows how churches hold capacity for support in response to natural disaster.

Along with churches, small community organizations in Papeno'o valley aided the clean-up. One community leader organized the youth of the valley for clean-up independently of the churches. They would meet at the local City Hall to plan clean-ups and then carry out their plans. When asked how people were able to mobilize themselves for clean-up or other needs, informants replied with "We are all family, and when we were heading to the CJA [the youth center to organize meetings] we would

see our cousins on the street and tell the to come." This shows how the history of genealogical land in Papeno'o impacts people's relationship to each other and their willingness to help one another.

While Papeno'o was affected, and the responses from inside Papeno'o Valley were strong, it is important to note that there was strong support from around the island of Tahiti. The Red Cross came to help, local musicians conducted a concert as a fundraiser, and local pearl company, Robert Wan, organized a Christmas day for the youth of Papeno'o where food and presents were given out (Concert solidaire 2015; Sinistrés : la Croix rouge 2015).

Overall, there were many responses by communities inside and outside of Papeno'o. This shows that people are invested in their environment and each other, and their care for these issues can be harnessed when thinking about long-term resiliency.

Government Responses

Government officials arrived on December 12, 2015 in the afternoon, which were appreciated by Papeno'o community members (community member of Papeno'o, personal conversation 2017). These were officials such as the President of French Polynesia, Edouard Fritch. During the flooding and months after the flooding, Fritch was publicly engaged with recovery and plans for the future in Papeno'o. He was present on the news, sharing his concerns about the area. He declared 895 million Fcfp would be deducted from the Victims of Disaster Assistance Account (CAVC) for cleaning public facilities, infrastructure repairs, and repairs to private property. He was willing to negotiate with families who lived in high risk areas of Papeno'o that were affected by the flooding (Sinistrés : les habitations 2015; Etat de calamité naturelle 2015).

The Mayor of Papeno'o was present during the flooding, as he is from Papeno'o and lives there currently. He allowed the City Hall of Papeno'o to be used for community meetings and gatherings to organize for clean-up.

Long-Term Adaptation and Resiliency

A common approach to long-term adaptation and resiliency is first assessing high risk areas and vulnerability to natural disasters. From there, studies then plan for the future to reduce these risks and vulnerability. This type of approach can be personally motivated, organized by community organizations or by government. Below is a table taken from the *Hawai'i Sea Level Rise Vulnerability and Adaptation Report* which can provide guidance on how to start to assess for the future of planning for an area such as Papeno'o. As the table shows, High Vulnerability + High Risk = **Should** be priority planning area, High Vulnerability + Low Risk = **May be** priority planning area, Low Vulnerability + High Risk = **May be** priority planning area, Low Vulnerability + Low Risk = **Unlikely** to be priority planning area (Eversole & Andrew 2014).

Table 2: Risk and Vulnerability Table

	High vulnerability	**Low vulnerability**
High risk	**Should be** priority planning area	**May be** priority planning area
Low risk	**May be** priority planning area	**Unlikely** to be priority planning area

(Eversole & Andrew 2014)

Long-Term Resiliency

Resiliency can include adaptive measures to strengthen Papeno'o against floods and strong rains. Resiliency in Papeno'o is plausible because, as was discussed in Chapter 1, the historical record of Papeno'o indicates that this area has been populated for centuries at high numbers. If maintaining

high population communities and mataeina'a iti were possible in the past, then with the minimal population that exists in Papeno'o today, there is reason to believe Papeno'o can continue that resiliency.

Community Resiliency and Adaptation Plans

According to interviews done with community members, a strong plan is lacking in the case of another flooding incident for the valley. When community leaders were asked if they felt prepared for the future, one person responded with "not at all." They felt prepared to respond to other natural disasters, such as a a tsunami, because they knew to go into high ground. But for a flood they felt unprepared (personal conversation 2017).

The community of Papeno'o has shown that they are extremely capable as first-responders and can mobilize for short-term responses to flooding. In the case of the December 12 flooding, the responses began immediately after the rains happened, and continued for months.

However, community members are not taking part in assessing vulnerable areas and adapting those vulnerable areas to decrease risk. In conversation, they could identify areas that are high risk and vulnerable, and name which families would be affected. But this is where information halted, and didn't continue towards creating plans for the future. Even if they aren't using the table listed above, other methods were not being used by community members to assess vulnerability and adaptability.

Government Resiliency and Adaptation Plans

There are plans written by different sectors of the French Polynesia government that predict weather issues and long-term adaptation and resiliency. Through interviews with government officials, information on relevant government agencies and plans for resiliency are gathered in a table on the following page. Following the description of each plan will be an analysis of the plans.

Table 3: Table mapping government sectors and plans for hazards and risks

State Actors	Role	Plan
Direction de L'Environnement	Produce climate change research and Strategic Climate Plan (PCS)	Strategic Climate Plan
Service de l'Urbanisme (SAU)	Study risks and hazards, produce PPR Phase 1	Plan for Risk Prevention (Phase 1)
Direction de l'Equipement	Recommend land changes based on PPR Phase 1 – flood management such as dams, etc.	Plan for Risk Prevention (Phase 2)
Haut-Commissaire	Produces Plan of Evacuation in case of Natural Disasters	Plan of Evacuation
Commune of Hitiaa O Te Ra	Community-level Education of Risks and Hazards Work with City Hall on PPR	
City Hall of Papeno'o	Community-level Engagement for Risks and Hazards Emergency Preparedness	

PCS: The Strategic Climate Plan (PCS) is a general plan for the 118 islands of Tahiti Nui that prioritizes climate change awareness and adaptation. This was a one-time plan completed in 2012 that encourages consultation of climate change data in every development decision, but it is not in-depth to specific areas. The PCS is used as a guide for research, but smaller area research plans will be more in-depth.

PPR: The Risk Prevention Plan (PPR) is a plan completed by the Service de L'Urbanisme. As described by the *State of Environment* (2009):

> The PPR is an indispensable tool for adapting to the effects of climate change in French Polynesia. The PPR is a document regulating land use according to the natural hazards to which they are subjected, such as tsunamis, floods, field movements, cyclonic swells and earthquakes. This regulation ranges from the formal prohibition of building to the possibility of building under certain conditions.

Each commune in Tahiti ideally would have a PPR, which identifies high risk areas, vulnerability of the areas and adaptation to these areas. There are three parts to the PPR: Phase 1: A study conducted to determine risks and vulnerability of an area concerning a hazard. Phase 2: A study that prohibits building in high risk areas or determines how to build under certain conditions. Phase 3: The approval of the PPR by the mayor of the commune so that the PPR can be set in place.

For Tahiti Nui, there is one commune out of 48 communes that has completed Phase 1, Phase 2, and Phase 3, meaning that the PPR is in place. The remaining 47 communes rest in different phases of the PPR, and the PPR is currently being completed. Phase 1 has been completed for Papeno'o Valley and the SAU is in the process of completing Phase 2. There has also been a study focusing on high risk areas and vulnerability to flooding for Papeno'o.

The Plan of Evacuation: This plan is conducted by the Haut-Commissaire and is specific to each commune. This plan determines how the community and government services can respond in case of natural disasters. These government services include the fire station, police, and the weather service.

Analysis of Plans

PCS: The PCS holds valuable information concerning climate and how to adapt, but there seems to be little connection between this plan and the PPR, or the other government sectors that focus

on hazards. Accountability to climate change issues in plans is lacking between sectors, and there doesn't seem to be an entity that ensures that each plan concerning land will include climate change issues.

PPR: PPRs in Tahiti Nui are in a constant state of flux. PPRs are maladapted to Tahiti Nui, evidenced by the fact that there is one PPR that has completed all three Phases of the PPR and is now established and in place. The one commune that has approved the PPR is Puna'auia, which is one out of the 48 communes that exist in French Polynesia (Codification, 2018). PPRs have been brought to Tahiti Nui from France, where PPRs are much more likely to be fixed and have a clearer and greater impact.

According to interviews done with government officials, the PPR is not fulfilling its potential by constantly remaining in flux and is therefore maladapted to Tahiti Nui. There are several reasons for this maladaptation.

Firstly, local politicians don't want to put a PPR in place because the local communities are not happy with the PPR regulations and restrictions. There are specificities of Tahiti Nui that the PPR does not take into account, namely genealogical shared land ownership. Because community members of Papeno'o trace their history and genealogy to these lands, many feel they have the right to self-determine decisions about construction on their land (interview 2017; Nunn 2009, 220). The PPR will restrict building in high-risk zones, and not allow permits for building in these zones, or fine those who are in these high-risk zones currently. This is the greatest downfall of the PPR, even if the purpose is to protect people from living in dangerous areas.

Scholars Lata and Nunn (2009) state that in "developing countries" these top-down approaches, such as the PPR, tend to be malcommunicated to the communities they are intended for and communities are not receptive to their messages, even if it is for their benefit. They state:

Top–down approaches to community action are common in developed countries as solutions to

> issues of national concern, such as water shortages or disease awareness, whereas in developing countries top–down communication is often ineffective, both because of the inabilities of governments to disseminate messages of concern and because communities are often unreceptive to such messages.

The unreceptiveness of the PPR is enhanced by the fact that the PPR started in 1996, after many houses that were built in high risk areas were already completed. In short, people don't want the government to tell them to move out of houses that have been in place for many years.

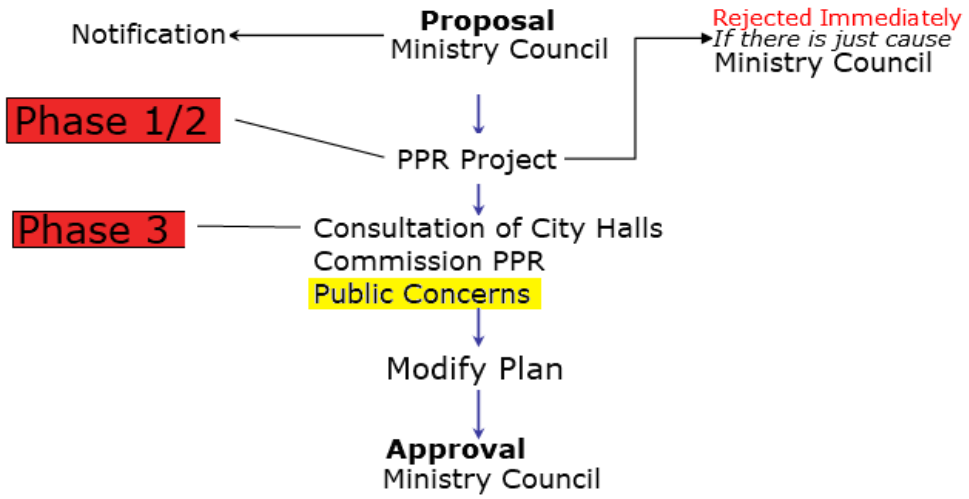
As Haururu members have shown through their actions and their views on the flooding, their valley is very important to them and self-determining construction in the valley is very important to them as well. This is shown through the protests that occured for the dam constructions in the 1990's. This is also shown most recently, by their views on the proposed extension of the hotel, Ecoparc that rests in the valley of Papeno'o. Community members expressed that the land was not happy with the proposed construction, and therefore reacted angrily with the rains of December 2015. Having outsiders determine what can and cannot be built in their valley, without their say, is not well-accepted by community members.

Currently, there is a lack of communication between Papeno'o community members and the PPR, which is most likely the cause of public unreceptiveness to the PPR. As shown in Fig. 14, community input does not come in until Phase 3, after "Consultation of City Halls." This input procedure is referred to as "Public Concerns," which is highlighted in yellow. Currently, the Mayor of the Commune of Hitaa O Te Ra does not want to create a fixed PPR, so the process of community input is not taken into account at all (interview with SAU employee 2017).

There seems to be a lack of established trust between government and community members because the community feels as if the government is telling them how to build on their land. Establishing trust between sectors is an important aspect of planning, and can be built through better

cooperation and communication between these sectors (Ayers et al. 2017).

Fig. 14: PPR process from beginning stages to ultimate approval by the Ministry Council



(PPR 2016, 5)

The PPR is meant to be a plan for long-term adaptation and resiliency to natural disasters, but because it is in flux at the moment, 47 communes in Tahiti Nui are unprepared for long-term adaptation and resiliency. Lata and Nunn (2011, 182) note the end result:

> Many Pacific Island governments (including Fiji) state that they are committed to long-term and sustainable solutions to the environmental challenges of the future (including those from climate change) and yet appear preoccupied with short-term, reactive, and commonly event-driven responses.

One of the most concerning issues about the PPR in flux is the privitization of the studies, which makes them unavailable to the public. For example, Phase 1 of the PPR has been completed for Papeno'o, which includes useful information on high risk areas and vulnerability. The study is kept within the SAU and due to policies, can only be shared when there is a private party asking for a building permit

from the SAU. Therefore, while the high risk zones are currently mapped out, the public is unaware of where they are, because they lack access to these maps.

Plan of Evacuation: This plan was unavailable at the time of the research.

Conclusion

Papeno'o Valley experiences heavy rain during the Matari'i-i-Ni'a season. This is due to the geography of Tahiti island, and the fact that there are high mountaintops where precipitation gathers and can cause torrential downpour and torrential characteristics to Papeno'o river.

The community was affected by the flooding of December 2015. There was also flooding in 2017 and 2018 in Papeno'o Valley, but in different areas than the flooding of 2015, showing that floods can be expected to become seasonal.

Immediate responses by community were strong, and lasted for months after the flooding because of the heavy damage that occured. While there is an effort by community to respond and take care of their land, there is low investment in looking at long-term adaptation and resiliency methods by community members.

Government responses to flooding were immediate as well, and government agencies are working on long-term ways to decrease risk to natural hazards in Papeno'o. While there is an effort to work on long-term resiliency methods in Papeno'o by government agencies, there is not a strong connection between community-level organizers and government agencies. Therefore, the studies and plans for Papeno'o will be completed, but not accepted by community-level decision-makers and community members.

Chapter 3 will explore ways to move toward long-term adaptation and resiliency planning that is participated in by both community members and government.

Chapter 3: Recommendations for Collaborative Watershed Management and Resiliency

This chapter takes the information from the preceding chapters and explores recommendations on how communities of Papeno'o can increase their resiliency to rainfall during the Matari'i-i-Ni'a season.

This thesis is "scoping" the issues for this valley to propose preliminary recommendations and to prioritize a few methods that can be addressed for resiliency. These recommendations are short-term, which are recommended to be implemented in 5 years, and long-term, which are recommended to be implemented in 6-15 years.

Resiliency

As stated in Chapter 3, resiliency is the capacity of a system to maintain itself despite disturbance (Berkes 2007, 286). Resiliency is a broad term that can encapsulate many different approaches to strengthening a community against natural disaster. In the area of flooding resiliency, planners can draw from case studies from around the world to provide guidance on how to approach this issue. However, case studies should be relied on with discretion because they are context specific, and therefore may be inappropriate for another area and context. An example of this is the Risk Prevention Plan (PPR), which works well in France, but does not necessarily work well in Tahiti Nui. While there are many aspects of the PPR and other case studies found worldwide that can be useful and should be used, there are important reasons to make resiliency site-specific at the same time.

Immediate Recommendations

Mā'ohi Knowledge

An approach could be to first take the cultural context of a place into consideration (M Lubell et al. 2003). Cultural knowledge of a place is important because there is also a wealth of environmental understandings as a guide for how to live and adapt to land. As Kānaka Maoli scholar Manulani Meyer (2014, 154) explains in her essay, "Indigenous Epistemology: Spirit Revealed," indigenous knowledge systems are enduring and there is value in perpetuating them. She states, "Knowledge that endures is a spiritual act that animates and educates. We are earth and our awareness of how to co-exist has always been present."

Knowledge that has endured among Mā'ohi people for thousands of years continues to inform and educate us into the present day. Mā'ohi knowledge has proven to work well with the land and the environment, as we have been capable of living and adapting to the islands of Tahiti Nui.

Cultural context could take into account oral histories and epistemologies of how to live with land.

Mā'ohi scholar Kareva Mateata-Allain (2008, 14) explains that it's part of Mā'ohi values to care for the land because it's traditional and an important part of who we are today: "Mā'ohi values include, but are not limited to: possessing strong links to family, roots, genealogies, oral traditions, and the land; and maintaining ties with the latter throughout the rapid changes brought on by globalization."

In the case of Papeno'o and flooding, the knowledge of Matari'i-i-Ni'a/Matari'i-i-Raro is valuable information. Below is a song written in 2017 by two cultural practitioners of Haururu on the topic of Matari'i-i-Raro. Haururu continues to celebrate the coming of Matari'i-i-Ni'a by examining the relationship between astronomy and the land. They are aware of when seasons begin and end, and how to adapt with each season. In the song below, Matari'i-i-Raro is recognized as a time to "prepare the land, restrictions, teaching" and to respect these initiatives because they are determined by ancestral knowledge and the gods. Community leaders and planners can remind people of this chant when

working for community preparedness.

MATARII I RARO

Ua faaite o Matarii i raro	Matarii raro has shown us
Te tomo nei tatou	That we have entered
I roto i te tau oè	In the time of restrictions
E tau teie no te haapiiraa	It is the time of teachings
E tau no te faaineine te fenua	The time of preparing the land
Ua huri te tau ta'oto te fenua	The time has changed, the land sleeps
Ua iti te mau mā'a ato'a	The food is of little abundance
E tau teie no te taraniraa	It is the time of restrictions
E tau no te rahuiraa	The time of the rahui
Ua ho'i te nuù atua	The gods have returned
Ua ho'i i te pô	Returned to the po
A faatura	We have respect
	(Calmélito-Heifara 2017)

Because they are already established, it is important to use the knowledge contained in Mā'ohi knowledge systems that have been in place for hundreds of years and are present today. This argument is supported by scholars and indigenous peoples who are using indigenous knowledge in their projects and management throughout the world (Shea et al. 2001, 61). There are several cases of this in the Pacific. Pacific scholars David Gegeo and Karen Ann-Watson Gegeo have written about indigenous epistemologies being used in Kwara'ae Genealogy Project in the Soloman Islands. Gegeo and Gegeo

(2001, 79) describe this as “marginalized peoples producing socially situated knowledge that addresses local problems, using their indigenous epistemologies.”

There is currently an effort by researchers and government agencies to incorporate Mā’ohi knowledge in contemporary times concerning marine management. This approach is the Rahui, which is “a system of restricting access to resources and/or territories” and is being used by communities throughout Tahiti Nui (Bambridge et al. 2016, 1). As Bambridge describes, “In the Polynesian context, tapu or rahui have less to do with a mystical abstract power than with the manifestation of efficiency in such domains as success, health, food and fertility” (Bambridge et al. 2016, 3). In short, in the case of the rahui, there are restrictions on certain fishing areas and types of fish based on times and seasons in order to ensure the prosperity of fish, directly benefitting the community’s resources and health.

Geographer Patrick Nunn (2017) refers to this as “geomythology,” which he describes as “folk tales [that] might not be pure fiction but actually based on memories of events our ancestors once observed.” This acknowledges that oral histories and myths are valid and should be taken seriously as knowledge that provides insight into the environment land management today.

Each area in Tahiti may be different in terms of their stories, but that is why local area study is needed as a basis of cultural context. To understand that oral histories and epistemologies are valid, and then further decide how to use what is relevant in land management today is a key research approach.

There needs to be an effort by government agencies to meet the people where they are at and incorporate these knowledges for their wisdom, as opposed to imposing foreign methodologies on the land (Smith 1999, 51; Thaman 2003, 2; Ayers et al. 2017). There is a need to incorporate indigenous knowledge systems in land management and hazard management in Tahiti Nui. This will result in more potential for resiliency to be applicable and enduring because it is relatable to Mā’ohi people. (Connelly, Lata and Nunn 2011; Poirine 1992).

Recommendation:

The first step is for the SAU and consultation companies who create the PPR to recognize the importance of cultural knowledge by attending cultural and historical workshops, so as to be educated on Mā'ohi knowledge and understandings. The PPR thus far has only incorporated Western approaches to natural disaster resiliency. These workshops could also be beneficial in establishing trust with Mā'ohi communities because it shows an effort by government agencies to understand cultural context. With the understanding that indigenous epistemologies hold knowledge and wisdom about land management, SAU can then examine how to incorporate relevant and practical information in their plans.

Traditional and Contemporary Decision-Making

Part of understanding cultural knowledge is recognizing how traditional decision-making plays out in Tahiti Nui. These systems of decision-making may still be in place in rural areas of Tahiti Nui such as Papeno'o. Through this understanding, there can be can an examination of why the PPR does not obtain approval by politicians on the local level. From there, the links in decision-making that are currently missing can be filled. Scholars Lata and Nunn (2011, 182) advocate for understanding traditional decision-making in Pacific Islands by saying, "The respect for traditional decision-making processes in Vutia and other Pacific Island communities can change from being a barrier to effective adaptation to enabling it, if traditional decision makers are empowered to make appropriate decisions about their environments."

To understand traditional decision-making in Tahiti Nui, it is important to look at the social structures that existed before Western contact. In general, the historical Mā'ohi power structure existed as:

Ari'i - Gained power from mana (power) which came from the gods and the fenua (land)

Tahu'a - Priests (usually of the same ari'i family, but the younger siblings of the ari'i, as the eldest held the most mana)

Ra'atira - Chiefs of Lowrank/Royal Servants

'Eiotai/'Ia to 'ai - Landlords/Property Managers

Manahune - commoners (Tetiarahi 1987, 48-52; Rigo 2016, 15-19)

This hierarchy reflects the order in which power was divided. The ari'i had the most mana, being so sacred that the community could not touch the ari'i or even look them in the eye. The manahune worked the land and the first fruits were given to the gods and then the ari'i. The ari'i were in charge of distributing the wealth of the goods and crops, leading religious ceremonies, and making good decisions for the community in relation to surrounding communities, among other duties.

Although the ari'i held the most mana, their mana was dependent upon the manahune and how strongly the manahune approved of ari'i decisions for the communities. It was a reciprocal relationship. As Rigo (2016, 18) describes:

> A genealogical system has a network-based logic, and there is no network without this idea of a permanent circulation which assumes continuity of circulation: from top to bottom, from the tutelary gods to the manahune, something must circulate — mana, mauri (sacred, prestige) — like a sap that comes up from the roots (tumu) and irrigates the slenderest twigs.

Because the community had input in community dealings, the ari'i could be displaced from his position if the community was not happy with how he rules. Or he could stay in power if he pleased the community. Since there was a strong reciprocal relationship between the ari'i and the manahune, scholars today are examining how Mā'ohi societies were consensual in decision-making. This is supported by cultural practitioners in Papeno'o, who say that Mā'ohi people have always been consensual. Haururu held a meeting at which they collected input from their group members on a

decision about a marae. They continue this process today (community member of Papeno'o, personal conversation 2017; Rigo 2016, 18-19).

With time, the ari'i role transformed into the Tavana role after the Battle of Fei Pi. The Tavana role is the Mayor of the commune of today, who is seen as the leader of the community (Gonschor 2008, 33). This leader/ari'i role makes good decisions for the community, but the community has input on how they want and see the leader ruling the area. This means that community has impact and its own power that is worth considering.

In contrast, the PPR studies currently do not state that they engage with local leaders in the Phase 1 process or the Phase 2 process. It is not until studies are done that "Consultation of City Halls" occurs (Phase 3) (Fig. 14).

Recommendation:

Because Tavana are so important to the community, SAU should engage with Tavana (Mayors) of the communes during the data collection period and about decision-making regarding land use in their areas. Also, community meetings should be held so that community can have input on data collection. Currently in the PPR process (Fig. 14) there is the process of "public concern" and "Consultation of City Halls" but these two inputs come after Phase 1 and Phase 2. They both should be moved to Phase 1.

Community Engagement

Community engagement in the PPR process is imperative for it to work well. Not only do communities hold knowledge about their area (through oral histories and memory of recent natural hazards), but the process of community engagement helps to keep peace in the traditional structure of society. People will have a say about how their land is affected by natural hazards and also in the

decisions relating to land management.

As things are now, community input is provided by select community members in Phase 1 of the PPR study about where there are flooding risks. But the testimonies gathered come from people chosen by PPR staff and are not gathered through a meeting that the general public can attend. Only after Phase 2 and 3 are conducted is there an opportunity for community involvement by holding meetings for community input before development occurs. There has been too little involvement with community, as the PPR has not yet made it to Phase 3.

The interviews conducted for this study indicate that people are not happy with the PPR and are not clear on decision-making processes or the determination of high risk areas or low risk areas. In interviews people have stated they don't trust the information that's produced in these studies because they have seen high risk areas change, but without explanation. In one study there will be a high risk zone, yet in the next study, the same zone will be a blue zone (meaning "able to construct," as opposed to red zone, which is banned from construction) (Doudoute 2017).

Not only is community input culturally appropriate for communities in Tahiti Nui, but input at this level is also valued in climate change resiliency worldwide. Community participation is a recognized key to effective planning implementation. Community members are usually first-responders (as in the case of Papeno'o) and they have capacity to be resilient over time. While the government can make plans, the community members are the ones who can and do enact resiliency over time. This is why the Sabatier framework (discussed in the Introduction) identifies stakeholder aspect and civic community recognition in Fig. 2. Because they are an important part of resiliency.

Lata and Nunn (2012) recognize that many developed countries have a combination of top-down and bottom-up approaches to climate change resiliency. But in the case of "poorer, developing countries, such as Pacific Island countries," there tends to be only top-down approaches that need to be modified and improved. As Nunn (2009, 220) states, "It is considered that the most effective way for

outsiders to inform environmental decision-making in the Pacific Islands is by having a direct input at a community level (bottom-up rather than top-down)."

Currently top-down and bottom-up approaches are being enacted in Hawai‘i. Waimānalo and Hau‘ula Community Resiliency practicums at the University of Hawai‘i included community input in the data collection and decision-making process (Hau‘ula 2011; Social Capital 2016).

Recommendation:

PPRs should include Participatory Action Research with community members because they've already shown interest in response and community members are protective of their valley, so it's important to let them self-determine on their land. Also, Participatory Action Research would allow more transparency of how the SAU operates and their duties, and doing so would help to establish trust between community, the Mayor, and government agencies.

Phase 1 of PPR: Hold meetings in relation to data collection, and seek community input on identifying areas that are high-risk

Phase 2 of PPR: Hold a visioning workshop where communities determine how they would like to see Papeno'o in the future. Give options of land use, restriction, and design for adaptation.

Benefits: The above steps would keep community members aware of areas that are high risk and vulnerable, and introduce them to methods of how to keep track of vulnerable areas.

Community Engagement through Churches

Another reason to engage with community is because there is an opportunity to work with churches in the areas. Christianity has a large influence in Tahiti Nui today; this is apparent when we consider the presence of several churches in each small village. While these churches have Christian influences and values, some, if not all, denominations have synchronized with Tahitian culture,

meaning that these churches have adapted to Tahitian culture in the language they use, the songs they sing, the values they preach, etc. The continued relevance of these culturally adapted Christian churches reinforces the point that Mā'ohi cultural values infuse all aspects of life in Tahiti Nui, making cultural context so important (Chailloux 2001; Mai 2006, 75-76).

As noted in Chapter 3, churches have also shown that they are strong first-responders. They have a far reach of influence, and they are well-respected. This type of reach and influence should be harnessed as a method of responding to natural disasters and developing resiliency to natural disasters (Nunn 2012, 183; Nunn 2017).

Recommendation:

With the input of church members, make a plan that assigns tasks to churches to divide responsibility in the next flood, so they can make use of their resources and not overlap.

Consider training local church leaders on natural hazard issues and climate change issues to create awareness.

Long-Term Recommendations

Mainstreaming Climate Change & Resiliency

Mainstreaming climate change is written by Pacific Adaptation for Climate Change (PACC) as a no-regrets approach. PACC's *Mainstreaming Climate Change Into Development* manual states,

> When climate risks are explicitly considered, the policy or project will not only be more effective at meeting its original development objectives, but also should not inadvertently create or increase vulnerability to climate change, and indeed should reduce vulnerability. Climate change mainstreaming will contribute to more sustainable development and more resilient communities. (Jasperse 2014, 3)

PACC states that every level of development and planning should incorporate climate resiliency, including community sectors. This is also supported by the regional Pacific organization, Secretariat of the Pacific Regional Environment Program (SPREP), which states, "As development policies, programmes, plans and projects are future oriented it is important that any investments in development take into account the likely effects of climate change and incorporate adaptation as necessary" (2000, 10).

As climate changes in Papeno'o, it is important to consider what the impacts could be and how to adapt to the future for strong and long-lasting resiliency. We know that rainfall could increase with time, and the negative impacts to Papeno'o could increase, either due to flooding damages or the frequency of rain events.

So far, government agents with the Service de L'Urbanisme acknowledge that climate change will worsen rain and flooding in the future, but are unclear on how that is incorporated in their plans. Meanwhile, the Direction de L'Equipment, which produces Phase 2 of the PPR, acknowledges that they incorporate development with climate change in mind (interview 2017).

Recommendation:

Continue to engage with climate change research concerning Papeno'o Valley. There should be clearer communication and accountability between Direction de L'Environnement, who produces the PCS, Service de L'Urbanisme, and the Direction de L'Equipement. Assign duties or tasks to Service de L'Urbanisme to ensure that climate is being taken into consideration.

Restore Natural Flood Zones

A common approach to resiliency in flooded areas is to restore and allow areas to flood when there is need. This is done in urban areas worldwide, such as Rotterdam and New Orleans. Design of

these cities allows areas to flood due to rain or riverine flooding. Floodable areas include marshes, canals, and parks that are improved in their ability to retain water and drain towards the ocean (Kimmelman 2017; Coastal Protection and Restoration 2017).

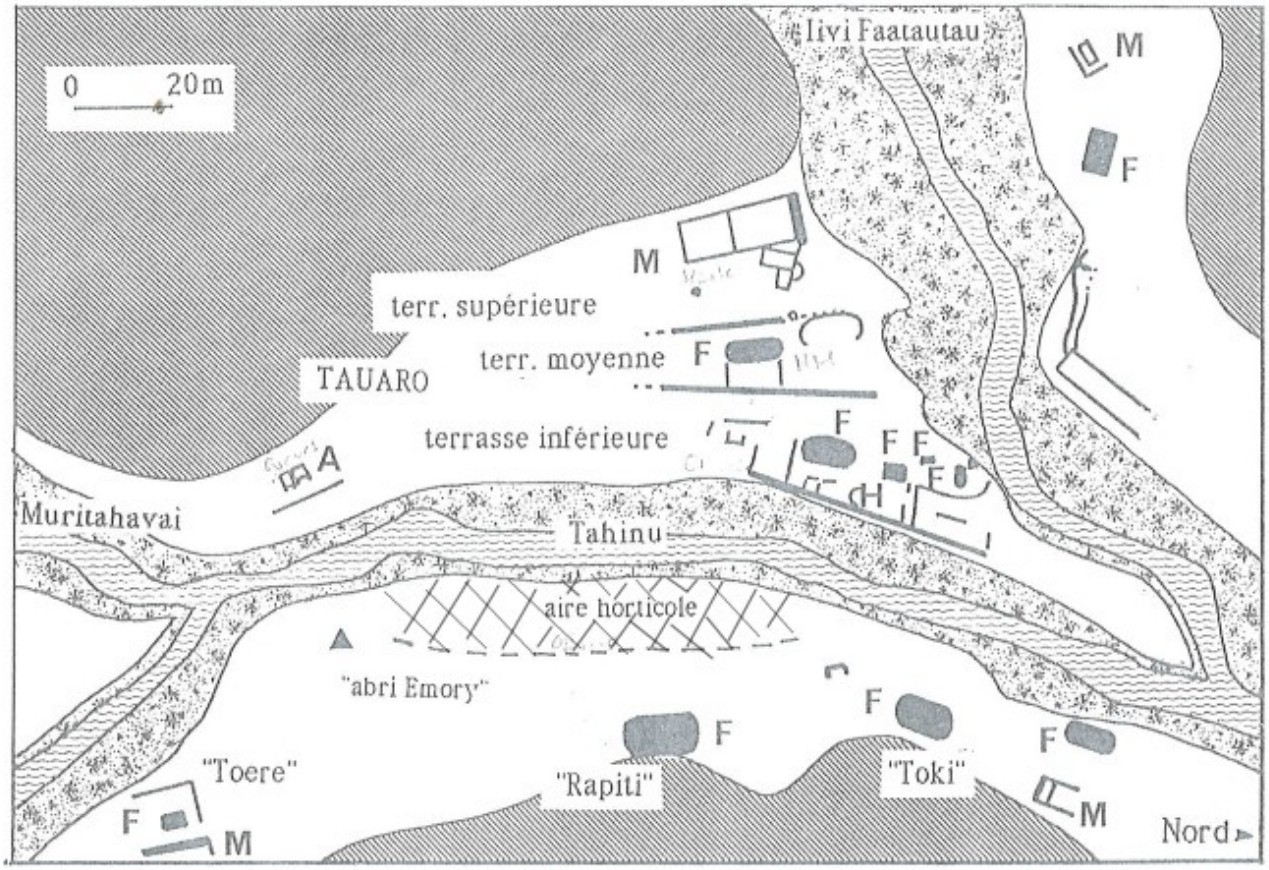
In the case of Papeno'o, the SAU is currently restricting construction in flood zones by not giving building permits in these areas (red-zone, high risk) and fining those who currently have houses in flood zones. Those same flood zones that are restricted for building could be restored to fully absorb the rainfall. One example to look to might be Luciano Minerbi's (1999, 213) "Indigenous Management Models and Protection of the Ahupua'a," which acknowledges indigenous methods of traditional land management in Hawai'i and establishes certain areas as flood zones, such as marshes and muliwai (estuaries).

The figure below (Fig. 15) shows how Mā'ohi communities have historically lived in Papeno'o Valley. There were areas that were left to flood, and next to these areas were the agricultural (horticultural) areas. Looking at the river, Tahinu, there is a grey area that was used as a floodzone. Next to it is an area labeled "aire horticulture," which is a designated agricultural area.

Today in Papeno'o there are two incentives to restoring these areas. Flood zones would be able to do their job in absorbing the rain and riverine flooding, and agricultural areas could be economically beneficial to the commune.

The population of Papeno'o currently has a primary sector that is "under-represented" with very small numbers of farmers (with 12 farmers in 2012) despite the potential for agriculture in the area (Tepava et al. 2014). Restoring flood zones and agricultural areas could align with community members' and government's desire for economic development and could motivate people to look further into resettlement and restoration of these zones (Nunn 2009).

Fig. 15: Settlements of Papeno'o Valley



Flood Zones

Agricultural Zone

M – Marae (sacred temples located on the highest level of land)

F – Fare (houses, located on the middle level of land)

H - Horticultural zones

A – Archery Platforms

(Orliac 1989, 17)

Recommendation:

After holding community meetings with proposed new zones, Service de L'Urbanisme should rearrange the PAD (Plan D'Amenagement Detaile) to designate zones for flooding and zones that could be used for agriculture.

Managed Retreat

Part of restoring natural flood zones and agricultural zones would be to move structures or houses that are currently in these areas. This approach is called managed retreat, in which structures or houses are resettled to other areas that are not high risk (Weiser 2015). Examining Fig. 15, we can see that fare (F) were historically far from flood zones and after agricultural zones (H). Managed retreat can be beneficial to those who are in high risk zones by moving them to areas that are safe, where they will be less affected by heavy rains and flooding.

The Mayor of Papeno'o has already expressed concern over houses that are in the high risk zones. There are government plans to give money to owners of houses in the red zone that were damaged in the December 2015 flooding for costs associated with rebuilding. But residents in high risk zones are now warned that their houses exist in the red-zone and are asked to think about resettling in the future, which would be their children's generation. For the next flood, the government will not be able to give financial aid because the residents in the red-zone have been warned (personal conversation 2017).

An example of which houses to retreat can be seen in Fig. 16 and 17 below. Fig. 16 is the map produced by the PPR Phase 1 with high-risk zones in red, which would be highest priority for managed retreat. Accompanying this map is Fig. 17, which gives a real-life perspective on Papeno'o river, the houses in the red zone, and which houses would be prioritized for managed retreat.

Fig. 16: Map of Papeno'o River with high-risk zones in red.

(PPR 2017, 53)

Fig. 17: Satellite photo of Papeno'o river

(Google Earth 2018)

Recommendation:

Offer agricultural zoning on vacated land to provide an economic incentive to those who will be resettled. For those who are moving, offer low risk zoned habitable land located in Papeno'o Valley, so as not to separate people from their genealogical lands.

Oral Histories in Schools and Flood Education

Programs that inform the public of natural disasters are encouraged in resiliency programs. The Hawaii Hazards Awareness and Resiliency Programs, a Hawai'i state program, aids communities in

developing programs to inform the public. “Increasing awareness of hazards,” is a top priority (HHARP n.d.).

One culturally appropriate way to communicate hazards to the public is through maintaining and disseminating oral histories. As established at the beginning of this chapter, oral histories contain valuable information about land management, natural disaster areas, and high risk areas, and these are validated by numerous scholars (Meyer 2014; Nunn 2017; Shea 2001).

In the case of Papeno’o, oral histories that familiarize the community with the valley and high risk areas should continue to be told and institutionalized in schools for the younger generations. One example of the benefits of this approach is understanding place names in the valley. There are stories relating to “Vaituaru [. . .] ‘the course water that destroys everything on its passage,’” that give an indication of how strong the river could flow (Hiro’a 2008, 20-21). Studying place names along the river could produce insight into where there are stronger flows and where there are less vulnerable areas.

Another example of this is the song written by Haururu and included at the beginning of this chapter. That song gives insight into the different seasons of Tahiti and how to prepare for rain during the Matari’i-i-Raro (dry season).

By educating youth about these stories youth can be made aware of their surrounding geography and environment, and therefore be prepared for different seasons and how they will be affected by these seasons.

Recommendation:

Incorporate oral histories in Papeno’o elementary school curriculum as flood awareness knowledge.

Conclusion

Climate change resiliency--in this case, resiliency to flooding in Papeno'o --is both possible and encouraged. Although resiliency methods can be studied worldwide, there is a need to adapt resiliency methods to the cultural context of Tahiti Nui.

The recommendations listed in this chapter are just some of many approaches to adaptation and resiliency that could be developed and used. These approaches included a variety of programs and design approaches, including incorporating local knowledge into resiliency efforts, further engagement with Mayor and community members through meetings, community engagement with churches, restoring floodzones, establishing floodzones as economic agricultural land when appropriate, and incorporating oral histories into education for youth. As a summary, Table 4 on the following page lists these recommendations, the responsible parties for implementation and timelines for implementation.

The benefit of these approaches would be that the community will understand high-risk zones because they are involved with identifying them and working with professionals from the government to be develop culturally-appropriate plans and resiliency on these issues.

Table 4: Recommendation Table

Implementation Action	**Responsible Parties**	**Time Frame**		
		1-5 years	6-10 years	11-15 years
Recognition of Mā'ohi knowledge as a guide to resiliency	SAU, Direction de L'Equippement, Papeno'o Mayor and community	x		
Engage with Mayor of Commune for data collection (Phase 1 of PPR)	SAU	x		
Community meetings and input for Phase 1 and Phase 2 of PPR	SAU, Direction de L'Equippement, Papeno'o Mayor	x		
Planning with Churches (meetings, plans for natural disaster response)	SAU, Direction de L'Equippement, Papeno'o Mayor	x		
Mainstream Climate Change and Resiliency into Plans	SAU, Direction de L'Equippement, Direction de L'Environnement		x	x
Restore Natural Floodzones	SAU, Direction de L'Equippement, Papeno'o City Hall	x	x	x
Managed Retreat	SAU, Direction de L'Equippement, Papeno'o City Hall	x	x	x
Zone vacated land as Agriculture Zones when appropriate	SAU, Direction de L'Equippement, Papeno'o City Hall	x	x	x
Oral Histories in Schools (Local Flood and Environment Education)	Papeno'o City Hall, Papeno'o Elementary School	x	x	x

Conclusion: ’A Hi’o i te ’ōpuara’a no Ananahi

(Summary and a look to the Future)

Summary:

Papeno’o Valley experiences recurrent flooding during the time of Matari’i-i-Ni’a. This is due to the south east trade winds (maraamu) that converge yearly with the northeast trade winds to cause high annual rains during the months of December, January, and February.

Papeno’o experienced torrential rainfall during December 2015, which caused severe damage to roadways, housing structures, and access to resources among other issues. With time, scientific evidence suggests that these rainfalls could worsen due to climate change, as discussed in Chapter 1 of this thesis. With worsening rainfall during Matari’i-i-Ni’a, the community of Papeno’o is put at a higher vulnerability to the consequences of flooding.

By using the Sabatier framework (Fig. 2) as a guide, I gathered data on the context of the area, government agencies, and community responses. This framework helped to organize the data holistically to examine the watershed, how it is managed, and which actors in the community and government do the managing.

I spent 6 months in Papeno’o Valley, Tahiti from June 2017 to December 2017, doing a combination of data collection and volunteering with the cultural group Haururu. Spending six months with Haururu, in the least, was needed to conduct this research. I learned during this time that our level of trust with one another would have not been as strong as it became if I had spent less time with them. And in order to do research that matters, that is reflective of the community I’m working with, it’s necessary to spend time with the people. My interviews with people would not have happened in some cases if I were not physically available to show up to different workshops, meetings and ceremonies to

show them that I am dedicated to this place. Going back to the Mā'ohi protocols of fa'atauaroha described in the Introduction of this thesis, I would have not enacted this fa'atauaroha fully and been sincere if my research were conducted within 2 or 3 weeks. If this were the case, I would have been taking more than I was giving, which is not the point of the fa'atauaroha. Six months in itself is not long enough, and my relationship with Haururu is still not over, I need to continue this relationship for a very long time in order to be fully genuine in this fa'atauaroha.

During the six months, I was able to gain trust of Haururu members to then be able to interview them regarding the floods of December 2015, about their responses and how they are working towards resiliency for the future. I was also able to interview government agencies, Service de L'Urbanisme and Direction de L'Equippement about their process of the Risk Prevention Plan (PPR) and acquire relevant government documents, such as PPR Phase 1.

In writing this thesis, I started with the context of Papeno'o, which includes cultural context, history, and present-day context. To understand the context of Papeno'o I outlined the most significant historical and present-day influences. People of Tahiti may strongly identify with the land that they live on because of their genealogy. In general, the population of Papeno'o Valley live in this valley because they have land tenure access and a desire for access to genealogical lands. Today, houses are gathered around the coast of Papeno'o, and some houses are built in very high risk flood zone areas. Because of the fact that houses are built in high risk flood zones, there was severe damage to houses and people during the flooding of December 2015.

Immediate responses by community were strong, and lasted for months after the flooding because of the heavy damage that occured. These responses were by Papeno'o residents, Tahiti residents island-wide, and churches of the area. While there is an effort by community to respond and take care of their land, there is low investment by community members in looking at long-term adaptation and resiliency methods.

Government responses to flooding were immediate as well, and government agencies are working on long-term ways to decrease risk to natural hazards in Papeno'o. While there is an effort to work on long-term resiliency methods in Papeno'o by government agencies, there is not a strong collaboration between community-level organizers and government agencies. Therefore, the studies and plans for Papeno'o have been completed by the SAU, but not accepted yet by community-level decision-makers and not accepted by community members, as explained in Chapter 2.

Resiliency is possible and encouraged in regards to climate change issues, and specifically in this case, to flooding in Papeno'o. Although resiliency methods can be taken from case studies worldwide, there is a need to adapt resiliency methods to the cultural context of Tahiti Nui.

Findings:

Findings show that community responses are strong in response to natural disaster in Papeno'o, but that there is little investment in long-term resiliency. Findings also show that there was support by government agencies immediately after the event and up until recently. Government agencies are much stronger at preparing for long-term resiliency, but do not take advantage of the capacity of the community as responders and planners in long-term resiliency.

The most potentially influential approach by government agencies is the development of the PPR in 1996. This Plan is a study of natural disasters focusing on what areas are high risk and how to adapt communities to lessen the effects of natural disasters. For Papeno'o, the PPR is currently in progress establishing which areas are high risk and how to manage these areas. Phase 1 is complete, and Phase 2 is currently being conducted.

While this PPR holds significant value and information for natural disasters, this plan seems not well-received by local politicians and is not as effective as it could be. As of currently, information gathered for the PPR is unavailable to the public, which leads the public to be unaware of high risk

areas in Papeno'o. This plan also does not incorporate community knowledge into the development of the plan.

Recommendations:

Overall recommendations are to improve collaboration between Papeno'o community and government agencies on resiliency. This can first be done by recognition from government agencies that Mā'ohi knowledge is applicable and holds valuable site-specific information through oral histories about people in their own valley. A second step is to acknowledge the capacity for response by community members and churches of the area, and then harness these responses. This can be done by organizing community to think about their roles and duties in responses, how they can be better organized in responses, and planning long-term into the future.

Also a design recommendation is that houses in the high risk flood zones should consider moving to lower risk areas or adjust housing to be elevated or on stilts. People resettling can be incentivized by designating the newly evacuated high risk zones as agriculture zones, which could be an economic benefit by expanding production and cultivation of agriculture goods.

And finally, recommendations include incorporating oral histories in schools as a way to educate future generations about their surroundings. This could benefit students by cultivating their understanding of seasonal changes and the risks associated with them.

Limitations:

For the research process, my data collection consisted of interviews with members of Haururu. While these members were residents of Papeno'o, their involvement with only one community group may not have given a diverse set of opinions. I was unable to reach the churches of the area (the Protestant Church and the Catholic Church).

I was also unable to acquire the Plan of Evacuation, which details the immediate responses by social services in a natural disaster situation. These services include the fire department and the local police of the areas.

For the recommendations, I wasn't able to locate policies that would guide the implementation of the recommendations. For example, more research needs to be done to determine the procedures required to change the data collection process of the PPR to include more community meetings.

Future Extensions:

Future extensions would look at which policies and government agencies could help develop stronger community resiliency with community members. If work will be done through the PPR, then there needs to be policies to support changes in data collection, community meetings, and community engagement.

An important future extension is informing Papeno'o community about my research findings as a way of ha'amāuruuru (giving thanks). The community members of Papeno'o welcomed me into their valley, their homes, their lives and shared with me personal stories of their experiences in this valley. To give thanks to the people I worked with and to te fenua (the land) in general, my responsibility is to give back what I information I have gathered in accessible ways.

This can be communicated by working with Haururu to conduct a presentation and hand out pamphlets with findings. These findings will include the organized information about community responses (churches, community organizations), information about identified high risk zones, and suggestions about how community responses could include their own methods to identify high risk zones and manage those areas. From there, communities could be empowered to harness this information into resiliency and preparation for the future of Matari'i-i-Ni'a, with the added foreshadowing of climate change.

By working with Haururu and community members and the output of the meetings, I would be glad and available to then be a liaison between Papeno'o Valley community members and SAU to look at better collaborative methods between the two.

Going back to the Introduction of this thesis where I discuss Audre Lorde's quote "The master's tools will not dismantle the master's house," as shown through this work, I did not dismantle the master's house through this thesis (Kauvaka 2016, 130-151). This quote is important because it gives a frame of reference when thinking about intentions and goals of research and life in general. Overall, Audre Lorde is indicating the need to dismantle the master's house, which in the case of Tahiti Nui are the Western systems that are on our land and have oppressed us for generations. This is through an accumulation of the era of nuclear testing, through previous Urban Planning, through language imposition, through suppression of Mā'ohi knowledge, etc. My intention aligns with her own in that the master's house does indeed need to be dismantled and there needs to be change in Tahiti Nui towards a decolonized land.

In doing this thesis, in an attempt to center Mā'ohi knowledges, community, and our longevity into the future, I used the master's tools to create interior design of the house so it reflected our own values, our own mats, and tapas. Along the way, I also learned how to create my own fare (metaphorically speaking), and even more appropriate, the 'utuāfare. By working with Haururu, I worked with community to imagine how our Mā'ohi knowledges and epistemologies can redesign our lives back to those communal values of living with land towards communal goals of perpetuation of our lives and culture.

While Matari'i-i-Ni'a is a season that could cause potential damage and danger to those in Tahiti, it also is part of a larger system that has been regarded as a sacred time of potential, celebration, and abundance. The history of Matari'i-i-Ni'a in Tahiti Nui and Papeno'o Valley has been a successful

one, with Mā'ohi communities celebrating the abundance that comes with the season, adapting to changes in weather patterns, and thriving in these environments. This type of adaptability can be harnessed for contemporary times of seasonal change, torrential downpours, and the effects of these issues. There are currently churches and community members with incredible adaptability and potential to build more capacity for resiliency through continuing Mā'ohi knowledge in schools and harnessing community responses for the future. There is incredible potential for more collaborative efforts by government agencies and community members to work together on data collection and plans for the future. With climate change threatening an ambiguous change in rains and seasons, the valley of Papeno'o could build its resiliency methods to be even more adaptable to this future.

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